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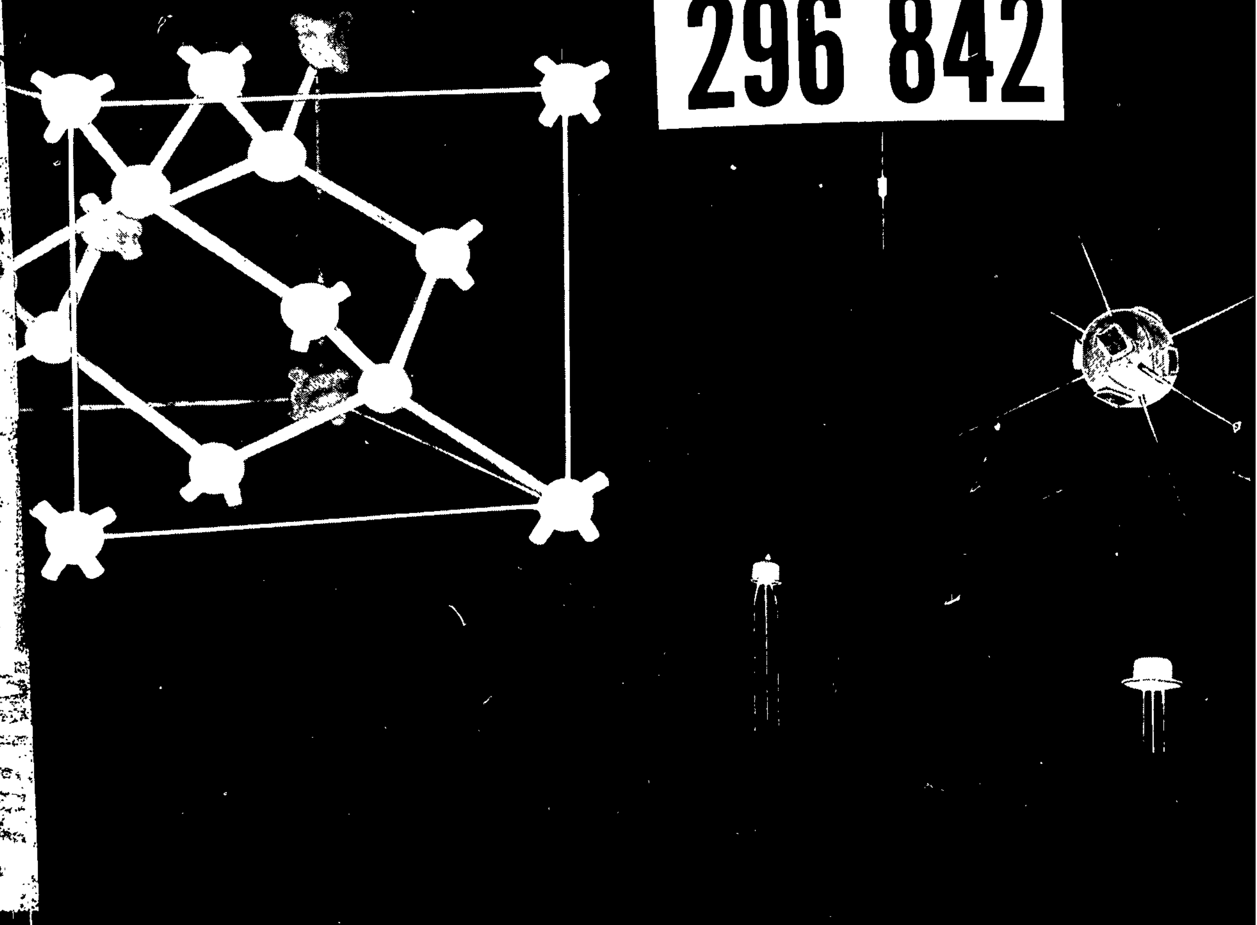

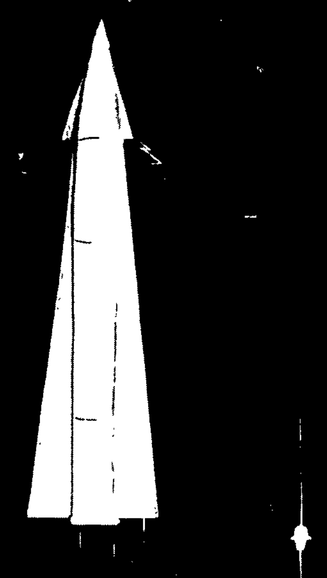

PRODUCTION ENGINEERING MEASURE

MECHANIZATION OF SEMICONDUCTOR DEVICES

2N560, 2N1051, 2N1072, 2N1195, 1N664, 1N665
1N666, 1N667, 1N668, 1N669, 1N673
1N675, 1N697, 1N701 and 1N810

QUARTERLY PROGRESS REPORT NO. 13
FOR THE PERIOD
JUNE 26, 1962 TO SEPTEMBER 26, 1962

CONTRACT NO. DA-36-039-SC-81294

ORDER NO. 7641-PP-59-81-81

PLACED BY
U.S. ARMY ELECTRONICS MATERIEL AGENCY
PHILADELPHIA, PENNSYLVANIA

Western Electric Company
INCORPORATED
LAURELDALE, PENNSYLVANIA

Copy No. 15

PRODUCTION ENGINEERING MEASURE

MECHANIZATION OF SEMICONDUCTOR DEVICES

2N560, 2N1051, 2N1072, 2N1195, 1N664, 1N665
1N666, 1N667, 1N668, 1N669, 1N673
1N675, 1N697, 1N701 and 1N810

QUARTERLY PROGRESS REPORT NO. 13

FOR THE PERIOD

JUNE 26, 1962 TO SEPTEMBER 26, 1962

OBJECT:

Design And Provide High-Volume Production Equipment For Use In The Manufacture Of Semiconductor Devices.

CONTRACT NO. DA-36-039-SC-81294

ORDER NO. 7641-PP-59-81-81

Prepared by: M. N. REPPERT
Approved by: R. E. MOORE

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SECTION I

ABSTRACT

This report reviews the progress made in mechanizing the manufacture of 2N560, 2N1051, 2N1072 and 2N1195 transistors and of .4 watt diodes for Nike Zeus. It covers the thirteenth quarter, June 26, 1962, to September 26, 1962, of Contract No. DA-36-039-SC-81294. Status of this Production Engineering Measure is shown in the table below by listing the number of machines in a given developmental phase. Numbers in parenthesis indicate the number of machines in a given phase scheduled for deletion from the contract. Status of each of the 34 machines is determined by the developmental phase of its major components unless a delinquent component hinders progress.

PHASE	NUMBER OF MACHINES		
	Transistor	Diode	Total
Completed	7	4	11
Shop Trial	3	3	6
Prove-In	5	4	9
Construction	3(1)	1	4(1)
Design	0	1(1)	1(1)
Development	0(1)	0	0(1)

In addition to work done on the machines, work continued throughout the quarter on a proposal to modify the contract. This proposal will be submitted next quarter.

The remained of this abstract summarizes the status of both transistor and diode mechanization programs by grouping machines of like status. Detailed reports on each incomplete machine are contained in Section III.

TRANSISTORS

Completed: seven (7) machines. Of these, the following three were completed this quarter: Cleaning Header Lead Wire (2N560-2N1051-2N1195), Wafer to Header Bonding (2N1195 & 2N560-2N1051) and Special Test Set (2N1072). Shop trial of the Special Test Set (2N1072) was considered completed with satisfactory completion of in-plant acceptance testing. Repeatability of test measurements and mechanical performance during acceptance testing were within the specified limits.

Excellent progress was made on both the Cleaning Header Lead Wire Machine and the Wafer to Header Bonding Machine. Both completed prove-in and shop trial this quarter. Wires cleaned on the Cleaning Header Lead Wire Machine were satisfactory in subsequent operations. No major problems were encountered while operating the machine; an effervescing problem has, however, lowered the hourly output of the machine somewhat. The Wafer to Header Bonding Machine satisfactorily completed shop trial by automatically bonding both silicon and germanium wafers. Several modifications were required before automatic header loading and unloading were reliable. Several minor safety interlocks will also be added next quarter to adequately protect the operating mechanisms.

Shop Trial: three (3) machines - Header Assembling, Wafer Loading No. 1 and Coding. Only Wafer Loading Machine No. 1 remained in shop trial through the quarter. Shop trial is still held on this machine while a new linear track and sensing system are provided. The track and sensing system will be installed early next quarter.

Both the Coding and the Header Assembling Machines advanced to shop trial from prove-in. A number of changes were made on the Coding Machine before

completing prove-in. These changes have increased its speed and reliability. Shop trial had not started as the quarter ended. The entire Header Assembling Machine is being used for shop trial, since a problem at the welding station was solved early in the quarter. Mechanically, it works satisfactorily; however, efforts to minimize a lead location problem caused by the tip welding operation continue.

Prove-in: five (5) machines. Wafer Loading Machine No. 2, the Packing Machine, the 2N1195 Wafer Screening Machine and the 2N560-2N1051 Wire Bonding Machine are held in prove-in since the beginning of the quarter while modifications are completed. As for Wafer Loading Machine No. 1, a new track and a new sensing system are required for Machine No. 2. Prove-in cannot resume until the sensing system is completed and the track and sensing system are installed. Prove-in of the 2N1195 Wafer Screening Machine is delayed because critical alignments and precise action could not be obtained repeatedly. Parts are being reworked or remade as necessary. Construction of the modified hand feeding attachment for the Packing Machine has started. It should eliminate the one percent loading failures experienced earlier in prove-in. Redesign of the wire bonding station for the Wire Bonding Machine was completed late this quarter and construction was started. Shop Trial will be completed next quarter.

Some prove-in progress was made on the Painting and Coating Machine even though the exhaust system was not installed so the process prove-in could begin. Change-over equipment was proven-in partially. Work was also done on a handling problem: transferring freshly painted transistors back to the handling trays. This work continues.

Construction: four (4) machines. No work was done on the Emitter Etching Machine since it is scheduled for deletion. It should be deleted once the proposed contract modification is accepted. The Can-Getter Assembly, the Can to Header Closure Weld, and the 2N1072 Wafer Screening and Electrical Probe Testing Machines continued in construction through the quarter. Final assembly has started on all three machines; it is held on the Can-Getter Assembly Machine because of a can-loading problem encountered on a similar machine of Contract DA-36-039-SC-72729. It will resume as soon as the problem is resolved.

Final assembly of the Can to Header Closure Weld Machine started in September. Progress was hindered because construction effort was concentrated on a similar machine on Contract DA-36-039-SC-72729. Construction on the 2N1072 Wafer Screening and Electrical Probe Testing Machine is nearing completion. Concurrent mechanical prove-in has not started as expected; however, the two test module are available for prove-in.

Design: no machines.

Development: one (1) machine, D-C and Switch Testing (2N560-2N1051). Machine development has stopped; its deletion is proposed in the proposal for contract modification now being prepared. Test module developments on certain critical parameters continue.

.4 WATT DIODES

Completed: four (4) machines. Of these, two (2) machines were completed this quarter; Lead Straightening and Racking, and Coding. Both were in shop trial as the quarter began. Shop trial results were very satisfactory on both machines. No problems were encountered on the Coding Machine. Only

minor adjustments were required to correct problems on the Lead Straightening and Racking Machine.

Shop trial: three (3) machines. The Etching, Oxidizing, Cleaning and Drying Machine advanced from prove-in. Both the Stud Lead Cleaning and the Packaging Machines continued in shop trial. No work was done on the Stud Lead Cleaning Machine; however, plans were made to evaluate the cleaning process. Modifications were made to the Packaging Machine to provide more clearance for styrofoam blocks. The original tolerances established for these blocks could not be met. No other work was done on this machine.

Prove-in of the Etching, Oxidizing, Cleaning and Drying Machine was completed near the end of the quarter. A number of components were installed before starting process prove-in. Acid leaks occurred during initial process prove-in; some parts were damaged not only by the leaks but also by acid fumes. Initial processing results were comparable to normal production.

Prove-in: four (4) machines. Considerable progress was made on the Gold Bonding, the Assembling Case to Stud and Welding, and the Final Electrical Testing Machines as prove-in continued through the quarter. Construction was completed concurrent with initial prove-in of the Low Temperature Reverse Current Testing Machine.

Several operating problems appeared during prove-in tests of the Low Temperature Reverse Current Testing Machine. They have been or are being corrected. The tests indicate that diodes are cooled to the specified temperature in 40 to 60 seconds, and that a heater is needed to return the temperature sensing diode to room temperature in a reasonably short period.

Modifications made early in the quarter advanced prove-in sufficiently so that all stations of both the Gold Bonding and the Assembling Case to Stud and Welding Machines could be operated. The designed, production rate of the Gold Bonding Machine was maintained for short intervals in the latter part of the quarter. Continuous operation should be possible once the redesigned wafer loading station is completed and proven-in. Correcting assembly station problems and several lesser problems on the Assembling Case to Stud and Welding Machine raised its efficiency to about 60 percent. By eliminating three other problem areas, highlighted by the increased efficiency; its efficiency should readily be increased additionally.

Prove-in of the Final Electrical Testing Machine is nearing completion. Final check-out of test modules has started. However, it cannot be proven-in completely until the unloading station is installed and proven-in. Shop trial can begin without this station.

Construction: one (1) machine, Gold Plating. Construction is being completed concurrent with installation. It continued through the quarter due to a delay of several weeks.

Design: two (2) machines. Both the Data Producing Test Set and Wafer Evaluation continued in design through the quarter. No work was done on Wafer Evaluation, since it is scheduled for deletion in the proposal to modify the contract. The same proposal reschedules completion of the Data Producing Test Set for 1963. Design has started. It will be built by the Western Electric Company because of testing limitations on proposed commercial test sets.

SECTION II

PURPOSE

This Production Engineering Measure will provide the mechanized equipment needed to supply semiconductor devices for Nike Zeus. Present production planning is based on the NIKE ZEUS Defense Production Program, Phase 1, Secretary of Defense Plan, dated 8 September 1961.

Since Contract Modification No. 6 was approved, the following specific provisions remain in the Contract:

1.1 Provide the engineering approach to establish capability to manufacture 2N560, 2N1051, 2N1072 and 2N1195 transistors on a mass production basis short of actual fabrication of equipment specified under items 1.2 and 1.3 below.

1.2 Provide high volume production equipment limited to the number and types of machines as specified below. The machines shall be capable of producing parts directed toward a rate of at least 12,000 transistors, conforming to the applicable specifications, per two (2) shift, eight (8) hour, five (5) day week.

	Operation and Type of Machines	Quantity of Machines
1.2.1	Cleaning Header Lead Wire	1
1.2.3	Header Assembling	1
1.2.4	Wafering (2N560-2N1051)	1
1.2.5	Wafering (2N1195)	1
1.2.6	Wafer Loading (2N560-2N1051)	2
1.2.7	Wafer Screening (2N560-2N1051)	1

1.2.8	Wafer Screening (2N1195)	1
1.2.9	Wafer to Header Bonding (2N560-2N1051)	1
1.2.10	Wafer to Header Bonding	1
1.2.11	Wire Bonding (2N560-2N1051)	1
1.2.13	Emitter Etching (2N560-2N1051)	1
1.2.14	Can-Getter Assembly	1
1.2.15	Can to Header Closure Weld	1
1.2.16	Painting and Coating	1
1.2.17	Coding	1
1.2.18	D.C. and Switch Testing (2N560-2N1051)	1
1.2.19	Packing	1

1.3 Provide high volume production equipment limited to the number and type as specified below. The machines shall be capable of producing parts directed toward a rate of at least 12,000 2N1072 transistors, conforming to the applicable specifications, per two (2) shift, eight (8) hour, five (5) day week.

	Operation and Type of Machine	Quantity of Machines
1.3.1	Wafer Screening and Electrical Probe Testing	1
1.3.2	Special Test Set	1

2.1 Provide the engineering approach to establish a capability of manufacturing the 1N664, 1N665, 1N666, 1N667, 1N668, 1N669, 1N673, 1N697 and 1N701 type diodes on a mass production basis, short of actual fabrication of equipment specified under Item 2.2 below.

2.2 Provide high volume production equipment limited to the number and types of machines as specified below. The machines shall be capable of producing parts directed toward a rate of at least 30,000 diodes, conforming

to the applicable specifications, per two (2) shift, eight (8) hour, five (5) day week.

	Operation and Type of Machine	Quantity of Machines
2.2.1	Wafer Preparation	1
2.2.2	Wafer Evaluation	1
2.2.3	Stud Lead Cleaning	1
2.2.4	Gold Bonding	1
2.2.5	Etching, Oxidizing, Cleaning and Drying	1
2.2.6	Assembling Case to Stud and Welding	1
2.2.7	Lead Straightening and Racking	1
2.2.8	Low Temperature Reverse Current and Shock Testing	1
2.2.9	Gold Plating	1
2.2.10	Coding	1
2.2.11	Coating	1
2.2.12	Final Electrical Testing (1N673, 1N675, 1N697 and 1N810)	1
2.2.13	Packaging	1
2.2.14	Date Producing Test Set	1

3.1 Prepare and submit quarterly reports - transistors and diodes.

4.1 Prepare and submit a final report - transistors and diodes.

5.1 Prepare and submit a mobilization planning report - transistors and diodes.

6.1 Prepare and submit monthly narrative reports - transistors and diodes.

SECTION III

MECHANIZATION ENGINEERING NARRATIVE

1. MECHANIZATION ENGINEERING STATUS

1.1 TRANSISTORS

This section reviews the progress made during the thirteenth quarter as work continued on the 16 incomplete machines for transistor mechanization. Reports on four (4) machines were discontinued upon completion in previous quarters.

They are:

1. Wafering (2N560-2N1051)
2. Wafering (2N1195)
3. Wafer Screening (2N560-2N1051)
4. Wafer to Header Bonding (2N560-2N1051)

This quarter, the narrative on Emitter Etching is deleted even though it was not deleted from the contract, as expected. It should be deleted next quarter once the proposed contract modification is submitted. Work has been held on the machine since the ninth quarter early in the construction phase.

The following three machines were completed this quarter:

1. Cleaning Header Lead Wire (2N560-2N1051-2N1195)
2. Wafer to Header Bonding (2N1195 & 2N560-2N1051)
3. Special Test Set (2N1072)

Overall status and progress of transistor mechanization is summarized by the table below. Numbers in parenthesis indicate

the number of machines in a given phase scheduled for deletion from the contract. The table indicates the status by showing the number of machines in a given developmental phase. Status of a given machine is determined by the phase of its major components unless a delinquent components is delaying progress. Overall progress during the quarter can be determined by comparing overall status at the end of the last two quarters.

PHASE	NUMBER OF MACHINES Last Quarter	This Quarter
Completed	4	7
Shop Trial	2	3
Prove-In	9	5
Construction	3(1)	3(1)
Design	0	0
Development	0(1)	0(1)

The remainder of this subsection contains reports on incomplete machines as well as machines completed this quarter. These reports review work done during the quarter, status at the end of the quarter, and briefly describe the operation being mechanized.

1.1.1 CLEANING HEADER LEAD WIRE (2N560-2N1051-2N1195) - R. W. Ingham

GENERAL

The Cleaning Header Lead Wire Machine has been completed. It will provide clean straight leads for mechanized Header Assembling. A problem, encountered during shop trial, has limited the output to 13,500 rather than the 15,000 leads per hour predicted during design.

The machine cleans only that portion of the lead involved in the glass to metal seal. Cleaning is accomplished by removing a thin layer of the lead by electropolishing. Two rinsing operations follow cleaning: a dip rinse and a spray rinse. Finally, the leads are dried thoroughly in a drying chamber before being unloaded and stored for future use. Figue 3-1 shows a view of the completed machine.

ENGINEERING STATUS

Prove-in and shop trial had been delayed since late in the eleventh quarter, when construction was completed, until the installation was completed and several leaky spray nozzles were replaced. Shop trial was completed in August with a minimum of operator training required. No major operational problems were encountered during the shop trial in September. Operating schedules are now being established so that the "Operation and Maintenance Specification" can be completed.

Initial lots of cut wires were troublesome. A wire feeding problem was encountered in the intial lots because the wires did not meet the lead straightness requirements. Once greater care was taken in cutting and handling the cut wires, the problem was minimized.

Shop trial experience, to date, indicates that machine will not clean the 15,000 leads per hour originally estimated during design. When the machine cleans more than 13,500 leads per hour, excessive effervescing takes place in the cleaning tank. This must be held to a minimum to avoid additional maintenance. Some work will be done to investigate the possibility and practicality of obtaining the original estimated output.

Two other minor problems were encountered: When the ambient temperature at the machine exceeds 90 degrees Fahrenheit, the rectifier thermostat cuts out the rectifier thereby cutting off the electropolishing current. A fan has been placed in the cabinet to cool the rectifier, and another exhaust fan has been ordered to provide more efficient air flow through the whole control cabinent.

The other problem involved the thermostat used to control the temperature of the acid. During initial warmup of the cleaning acid, the thermostat caused the heater switch to chatter while maintaining the operating temperature. This condition is readily corrected whenever it occurs by turning the power "off" temporarily after the operating temperature is obtained and the machine is being operated. This can be done because the cleaning operation is exothermic.

CONCLUSIONS

The cleaning process of the Cleaning Header Lead Wire Machine appears to be satisfactory. The Header Assembling Machine has had no lead loading problems and the subsequent Glassing operation continued to make satisfactory glass seals after the machine was introduced into the production cycle. While the designed, estimated output has not been attained, the actual output should be close enough to the original estimate to readily meet future Nike Zeus needs.

Having satisfactorily completed shop trial of the Cleaning Header Lead Wire Machine, this narrative will be deleted from future quarterly reports.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete "Operation and Maintenance Specification".

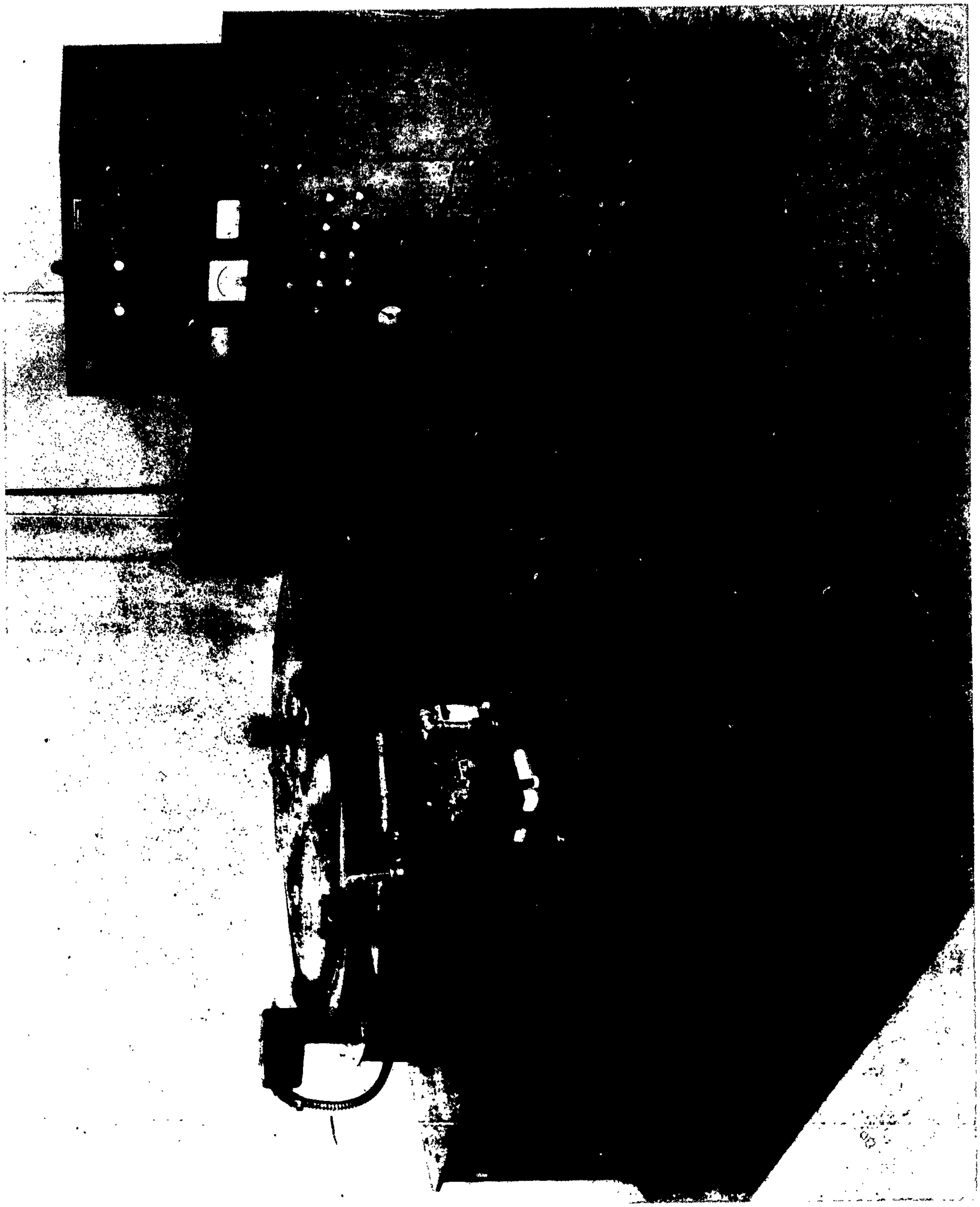


FIGURE 3-1.

CLEANING HEADER LEAD WIRE MACHINE

1.1.2 HEADER ASSEMBLING (2N560-2N1051-2N1195) - J. H. Blewett

GENERAL

The Header Assembling Machine will mechanize piece part assembly of TO-5 (200 MIL pin circle) headers in preparation for the Glassing operation. The machine is of the continuous, straight line type having separate stations for automatically inserting two additional non-oxidized leads, a glass ring, and a glass slug into butt welded collector-lead-platform subassemblies contained in ceramic stick molds. Free lead ends are formed and welded at the last assembly station.

Completion of prove-in was delayed and shop trial was limited until this quarter because of a problem at the tip welding station. It is now corrected, and shop trial of the entire machine has started.

ENGINEERING STATUS

As mentioned last quarter, the tip welding station had a tendency to pull the platform out of the mold during the crimping operation. This caused the platform to misalign and electrically short the leads. Two changes, which were made this quarter, have minimized the problem: the welded collector lead is now crimped slightly to decrease platform tilting during welding. And a hold-down mechanism was added to keep the collector-lead-platform subassembly in the mold during forming and welding. The hold-down mechanism is fixed and cannot compensate for variations in elevation from one mold to the next. It is now being spring loaded to compensate for various elevations and to prevent glass breakage while clamping the collector-lead-platform subassembly.

Since modifying the welding station and starting full shop trial, less than

one percent of the header assemblies started have failed to assemble. When trouble was encountered, it usually occurred at the welding station. Shop trial results, obtained by sampling the last 17,000 headers, indicate that less than five percent of the headers are rejected for poor lead location.

Shop personnel is trained to operate the machine. As experience is gained, the hourly output increases.

CONCLUSIONS

Having solved the tip welding problem, prove-in was completed. Once the glass breakage problem is solved at the tip welding station, the machine should complete shop trial satisfactorily. The lead location problem must still be minimized; however, it may now be due more to the glassing molds than the machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Minimize the lead location problem.
2. Complete shop trial.
3. Complete "Operation and Maintenance Specification".

1.1.3 WAFER LOADING - R. H. Morrow

GENERAL

The two Wafer Loading Machines (2N560 - 2N1051) will automatically load wafers from bulk into wafer trays with the active element up. Bulk wafers are placed into the saucer bottom of a vibrating outside feed, rotary bowl. Single wafer feed is obtained by transferring the wafers to a vibrating linear track, which rejects wafers having the active element down. At the end of the track, wafers are transferred to wafer trays by a reciprocating vacuum pickup. Tray indexing is timed to the pickup.

Shop trial of Machine No. 1 and prove-in of Machine No. 2 has been stopped temporarily so that the machines can be modified. The modifications consists of new type linear tracks and sensing systems.

ENGINEERING STATUS

Modification of both machines to incorporate a new linear feed track and sensing device was started early this quarter. The new track was necessitated by a change in wafer configuration which reduced the height of the mesa. This height reduction prevents mechanical sorting which was possible with the old configuration.

Construction of the new tracks and one sensing system was completed late this quarter. Minor changes are required on each machine before the new tracks can be installed. They will be made early next quarter.

The new track utilizes a series of small slots and grooves to eliminate undersize wafers or chips and a small air jet to eliminate oversize or double wafers. Inverted wafers will be eliminated by a photoelectric

sensing system and an air jet.

Another photoelectric cell will prevent overloading the linear track by stopping the rotary bowl when the linear track fills to the sensing point. The track is covered after the rejection stations to keep wafers from vibrating out of the track or flipping upside down.

CONCLUSIONS

A change in mesa height necessitated a change in linear tracks and sensing systems. This changes the prove-in and shop trial schedules on both machines. Prove-in and shop trial should be completed during the next quarter.

OBJECTIVES FOR NEXT QUARTER

1. Complete construction of the second sensing system.
2. Prove-in tracks and sensing systems on both machines.
3. Complete shop trial of both machines.
4. Complete "Operation and Maintenance Specification".

1.1.4 WAFER SCREENING (2N1195) - P. A. Lajoie

GENERAL

The Wafer Screening Machine (2N1195) is designed to process individual 20-mil geranium wafers from the unsorted bulk state through four operations and finally placed them in handling trays ready to be wafer bonded. Unsorted, bulk wafers placed in a vibratory bowl will be individually fed to a pickup point and placed in a pocket on a rotary indexing table for photoelectric sensing of wafer orientation. If the stripe is down, the sensing mechanism will initiate a flipper mechanism during wafer transfer to a second rotary indexing table. Here, visual inspection of the stripes and wafer will permit acceptance or rejection and selection of proper stripe orientation. While transferring wafers to the tray, a rotary pickup needle controlled electro-mechanically will orient the stripes properly for succeeding operations.

Prove-in continued through the quarter.

ENGINEERING STATUS

Initial prove-in was done last quarter concurrent with final assembly. All mechanisms performed the desired mechanical actions. No attempt was made at that time to transfer wafers. This quarter final prove-in was started. This involved precisely aligning all parts of the machine so that the precise actions necessary for efficient wafer handling were obtained. Due to the delicacy of the operation and the precise actions required, some parts had to be remade or reworked.

Prove-in progress was made on the wafer feeding system. It has resulted in redesign of the wafer chute on the vibratory bowl. Tests revealed that vibratory feeding could be improved by using a frequency other than 60 cycles

in order to take advantage of the bowl's resonance and the wafer's inertia. The new chute will take advantage of these factors and will aid in feeding and positioning the wafers for pickup.

CONCLUSIONS

Considerable progress was made in obtaining the precision needed to make the machine operative. However, overall prove-in progress was not up to expectations due to the time spent in obtaining the precise actions.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete prove-in.
2. Complete shop trial.
3. Complete "Operation and Maintenance Specification".

1.1.5 WAFER TO HEADER BONDING (2N1195 & 2N560-2N1051) - J. F. Anderson

GENERAL

The Wafer to Header Bonding Machine (2N1195 & 2N560-2N1051) mechanizes eutectic bonding of either silicon or germanium wafers to gold plated headers. Inputs to this machine are magazines containing loaded trays of oriented wafers and headers. These trays are automatically indexed through the machine and unloaded into empty magazines.

The bonding concept of this machine is similar to the 2N560-2N1051 Wafer to Header Bonding Machine. However, provision has been made for eutectic bonding of germanium as well as silicon wafers. It has eight bonding stations mounted on a rotary indexing table. As the table rotates, it automatically loads headers into side-entry bonding nests, loads and bonds wafers on the headers, and returns the wafer bonded assemblies to header handling trays.

Prove-in and shop trial of this machine were completed this quarter by wafer bonding 2N560, 2N1051 and 2N1195 wafers.

ENGINEERING STATUS

Initial prove-in efforts consisted of aligning the bonding heads and pickup chucks on the bonding nests and aligning the wafer pickup needle so that wafers were properly aligned on the headers without being damaged during handling and bonding. Then, the bonding temperature was set to provide uniform bonds at each bonding station. The desired temperature control has not been attained yet, because of delays in receiving components of the new header heat control system developed last quarter.

A similar control system has been installed on the 2N560-2N1051 Wafer to Header Bonding Machine. It operates satisfactorily and has required minimum maintenance; therefore, similar success is anticipated on this machine.

Modifications were made to the tray indexing mechanism before reliable indexing was obtained. After initial alignment of header pickup chucks, automatic loading and unloading of the side-entry bonding nests was possible so long as the header leads were relatively straight. New pickup chucks and additional clearance at the load and unload stations were provided during shop trial so that headers with bent leads could be transferred reliably. A bonding nest design change was also made before the nest loading problem was overcome completely. This change was necessary because the tabs on the headers did not always enter the tab recess in the nests.

All mechanical and electrical systems were checked out and operated as designed before starting shop trial. During concurrent prove-in and shop trial, automatic header loading and unloading were perfected. Initially, the machine was run at a reduced speed, approximately 600 bonds per hour, so that sufficient engineering observations could be made. These observations indicated that several minor safety interlocks should be added to insure adequate protection of the operating mechanisms.

Both mechanical and electrical yields of assemblies wafer bonded on this machine compare favorably with those of the prototype 2N560-2N1051 Wafer to Header Bonding Machine. Approximately 20,000 wafers were bonded during shop trial; most of these wafer were for 2N560 and 2N1051 transistors.

The following mechanical yields were obtained during shop trial. The

quantities represent the output during a three day period; two days were successive.

Code	Total Output	Good Output	Percent
2N560	3105	2989	96.2
2N1051	2352	2316	98.4

Mechanical rejects usually resulted from bent leads or header handling problems.

CONCLUSIONS

The foregoing results show that the 2N1195 & 2N560-2N1051 Wafer to Header Bonding Machine is mechanically reliable. Several interlocks will, however, be added early next quarter to adequately protect operating mechanisms. Subsequent electrical test results have also been satisfactory without the temperature sensing system. Once this system is added next quarter, electrical characteristics should be more uniform since the bonding temperature will be controlled more accurately.

This narrative will be deleted from future quarterly reports, since the machine is operating satisfactorily and has completed shop trial.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete "Operation and Maintenance Specification".

1.1.6 <u>WIRE BONDING (2N560-2N1051)</u> - M. K. Avedissian

GENERAL

The 2N560-2N1051 Wire Bonding Machine will thermocompression bond small diameter gold wire to the stripes of semiconductor wafers and to appropriate internal header leads. It automatically transfers wafer bonded headers in handling trays from load to unload magazines. At the bonding station, an operator will attach the gold wire to the appropriate contacts while viewing the work through a microscope.

Because piece part tolerances are larger than originally anticipated, it was necessary to redesign the bonding station. The small diameter gold wire will be continuously fed to the bonding tip and cut by precision scissors after bonding to either the base or the emitter lead. Bonds made must withstand 20,000 G's acceleration.

Design of the new bonding station was completed this quarter.

ENGINEERING STATUS

The material handling system of the machine was tested. It performs satisfactorily and will remain unchanged. Redesign of the bonding station was completed this quarter. Construction was started as the quarter ended.

With the new station, the operator's duties will change. Previously, the operator would have aligned wafer stripes on fixed reference points and then started a bonding cycle over which there was no control. Now, the operator will control motion of the bonding tips as well as the length of the bonding period. Anticipated production level of the machine has not changed; however, tolerances of the input material can vary over a wider range.

CONCLUSIONS

Objectives for the quarterwere met, for redesign of the bonding station was completed and construction was started.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete construction of the bonding station.
2. Provide controls for the new bonding station.
3. Complete prove-in.
4. Complete shop trial.
5. Complete "Operation and Maintenance Specification".

1.1.7 CAN-GETTER ASSEMBLY (2N560-2N1051-2N1195) - R. W. Ingham

GENERAL

The Can-Getter Assembly Machine will prepare cans for sintering by loading them with nickel powder; after sintering it will attach moisture getting material to the porous nickel sponge formed by the nickel powder during sintering. The sintering operation, not part of the machine, will also firmly attach the nickel sponge to the inside of the cans.

The machine is being built in two sections. The first section, can-powder loading, will do the following: orient and feed cans open-side up, insert cans into pallets, fill cans with measured amounts of nickel powder, tamp and level powder, and load pallets containing filled cans into a magazine. The getter loading or second section will do the following: unload pallets containing filled cans from a magazine one at a time, shake loose particles out of cans, measure and load cans with fixed amounts of getter material, fasten getter material to the nickel sponge by heating the cans, and load pallets into magazines for transportation to an activation furnace.

The design phase was completed June 30, 1962, when design of the getter loading section was completed. Construction has continued on both sections. A temporary hold was placed on construction late in the quarter until a can-loading problem is resolved.

ENGINEERING STATUS

About 40 percent of the machining was done this quarter leaving approximately ten percent not completed. Final assembly was started in September. However, both final assembly and completion of machining are held until the can-loading problem is resolved.

The can-loading problem occurred on a similar machine, designed for TO-18 cans, of Contract DA-36-039-SC-72729. The problem is caused by a back pressure in the loading track. As a result cans are jammed in the loading station and will not feed into the pallets. Modifications will be made to this machine to prevent a similar can loading problem once the problem is resolved on the Can Getter Assembling Machine of Contract DA-36-039-SC-72729.

During the quarter, modifications were started on the powder loading station to eliminate variations experienced with springs. Solenoids which operate the station are being replaced with double acting cylinders fitted with normally-open normally-closed 4-way valves. The valves and cylinders have been ordered, but have not been received.

CONCLUSIONS

Construction is about 65 percent complete. Due to the can-loading problem, construction was not completed this quarter as forecast. It will resume as soon as the can loading problem is resolved.

OBJECTIVES FOR NEXT QUARTER

1. Complete construction.
2. Complete prove-in.
3. Complete shop trial.
4. Complete "Operation and Maintenance Specification".

1.1.8 CAN TO HEADER CLOSURE WELD (2N560-2N1051-2N1195) - R. W. Ingham

GENERAL

The Can to Header Closure Weld Machine is being built to mechanize assembly, gas flushing and resistance welding of 2N560, 2N1051 and 2N1195 transistors. After the transistors are loaded, they will be flushed and charged with the desired ambient and welded one at a time in individual welding fixtures. A 16-station rotary indexing machine will transport the welding fixtures through the prescribed cycle. Air locks with suitable interlocks and controls were added so that the machine can be operated in conjunction with or without an oven or dry box.

Construction continues. Little work was done on the machine in August, because construction of a similar machine of Contract DA-36-039-SC-72729 was expedited.

ENGINEERING STATUS

All materials have been received. Machining of parts continued through the quarter. About 40 percent of the machining was done this quarter, thus completing about 90 percent. Final assembly was started in September, and has progressed steadily.

A minor modification will be made to the dry box enclosing the welding stations in order to connect the machine to an oven and dry box now on order. No further development of a loading mechanism was done this quarter because performance of a rack loader, now under test, was unsatisfactory.

CONCLUSIONS

To prevent additional delays in construction and completion of the machine, no more work will be done on the loading mechanism.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete construction.

2. Complete prove-in.

3. Complete shop trial.

4. Complete "Operation and Maintenance Specification".

1.1.9 PAINTING AND COATING (2N560-2N1051-2N1195) - C. A. Lowell

GENERAL

Painting and Coating operations for completed 2N560, 2N1051, and 2N1195 transistors will be mechanized by the Painting and Coating Machine (2N560-2N1051-2N1195). Similar operations for 2N559 and 2N1094 transistors will be done on the same machine by changing transfer chucks and nest sleeves. This machine will feature automatic transistor loading from magnetic trays and a storage magazine into the painting and coating stage, and automatic removal and replacement in the magnetic trays and storage magazine.

The machine has been moved to the manufacturing shop and installation is partially complete. Prove-in continues to be hampered because the exhaust system is not installed.

ENGINEERING STATUS

Installation of the machine in the manufacturing shop is complete except for the exhaust system. Slow delivery of parts and excessive work load have delayed its installation. It should be completed early next quarter, by October 1, 1962. Lack of this system has been the major problem this quarter.

The change-over equipment for 2N559 and 2N1094 transistors has been built and partially proven-in. Final evaluation will be made after effects of paint and varnish on the unload mechanisms are studied. Prove-in tests indicate that most problems involved with loading of TO-5 and TO-18 transistors and loading of masking tubes are resolved.

Work continued on the handling problem involved in transferring freshly

painted transistors from the painting stage to the handling trays. Some experiments were conducted with a magnetic transfer chuck, because handling of transistors after painting must be limited to contact with the leads. This requirement led to design of a lifting mechanism that will raise the transistors in the paper masking tubes so that the leads can be grasped or contacted for unloading. Final prove-in and evaluation of this phase of transistor handling will continue into the next quarter.

CONCLUSIONS

Incomplete installation of the machine has hampered prove-in of the painting equipment as well as the mechanized painting operation. But, a portion of the time lost has been used to good advantage to resolve some mechanical problems and increase the versatility of the machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Install exhaust system.
2. Complete prove-in.
3. Complete shop trial.
4. Complete "Operation and Maintenance Specification".

1.1.10 CODING (2N560-2N1051-2N1195) - C. A. Lowell

GENERAL

The Coding Machine (2N560-2N1051-2N1195) will mechanize handling and coding of 2N560, 2N1051, and 2N1195 transistors. By changing the coding table and pickup chucks, similar operations can be accomplished on 2N559 and 2N1094 transistors. The transistor storage and supply system follows the same pattern as on the Painting and Coating Machine. A side printing mechanism mounted tangent to the rotary index table will print code markings on transistors indexed past it.

Prove-in continued this quarter after the machine was moved to the assigned production area. It is completed, but shop trial has not begun.

ENGINEERING STATUS

Engineering efforts during final prove-in were concentrated as follows:

1. Increasing machine speed: A 50 percent increase was obtained by modifying a remote control valve to permit faster dumping of the air cylinder of the index table.
2. Increasing reliability of nest loading and unloading: A restricted area of the coding nests prevented complete reliability. The nest loading problem was resolved satisfactorily by installing an auxiliary loading platform and an air jet for final seating of transistors. Positive unloading was accomplished by providing a hook type profile on the lower surface of the pickup chuck.
3. Providing additional clearance on tray support rails and coding nests: The extra clearance was needed to load and unload transistors having bent leads reliably.

4. Providing a fail-safe indexing system: Several jam-ups were encountered before the system was developed. Other sensing stations were also studied and modified to assure consistent operation.
5. Proving-in the printing mechanism after timing the printer with the rotary index table: During initial tests transistors were ejected from the nests. Ejection was stopped by changing flow controls and obtaining the proper printing force.
6. Assembling and proving-in change-over equipment for TO-18 packages.

CONCLUSIONS

Prove-in of the Coding Machine is completed. It will code TO-5 and TO-18 transistors with little lost time for change-over. Consistent operation can be expected at an hourly output well above 1,200 per hour.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete shop trial.
2. Complete "Operation and Maintenance Specification".

1.1.11 D-C & SWITCH TESTING (2N560-2N1051) - K. C. Whitefield

GENERAL

Since the start of this project; reliable, multi-code, commercial test sets for high-volume production testing of D-C and 1 KC "h" parameters have become available. Therefore, development of electrical test equipment for this contract has now been concentrated on mechanizable test modules for the following parameters: switching time, capacitance, and 10 to 100 mc h_{fe}. One of the main targets of this work is development of test modules for these parameters which could be included on a single testing machine.

Test module developments continued this quarter.

ENGINEERING STATUS

In the latter part of this quarter, work proceeded rapidly with development of passive systems for metered output with adjustable band width on both 250 mc REh_{ie} and 10 to 50 mc h_{fe} parameters. (The 250 mc REh_{ie} development is being done under Contract DA-36-039-SC-72729). Results indicate that the correct methods have been chosen for both parameters and that 50 to 250 mc h_{fe} testing can be done in a straight-forward manner following the 250 mc REh_{ie} course. Formal technical reports on both these developments should be completed by January, 1963.

Capability of a capacitance test module has already been demonstrated on the Final Electrical Testing Machine developed for the diode portion of the contract. Work on mechanizable test modules for switching time tests is currently scheduled to start early next quarter. Reports on work done in these areas should also be completed by January 1963.

CONCLUSIONS

Development work, now in progress, should provide the bais for mechanizing other electrical parameters which can supplement commercial test equipment. Should Zeus requirements increase, high volume testing capability can be provided for testing transistors of this contract and contract DA-36-039-SC-72729 by purchasing a commercial, D-C and "h" parameter test set and by combining test modules being developed on another machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Delete the machine for this operation from the contract.
2. Complete test module developments.
3. Complete reports on test module developments.

1.1.12 PACKING (2N560-2N1051-2N1195) - C. A. Lowell

GENERAL

Completed 2N560, 2N1051, and 2N1195 transistors will be sealed automatically in a continuous strip of plastic envelopes on the Packing Machine. Perforations are provided between envelopes for easy separation. Automatic loading of transistors was considered, but feasibility studies have shown that a special hand feeding attachment will provide both highly reliable and low cost handling at the required hourly output.

ENGINEERING STATUS

Prove-in of the hand feeding attachment has not been restarted. During the quarter, redesign was finished and construction of a modified version was started. When completed, this attachment should eliminate the one percent failure experienced during earlier prove-in.

Complete control of the transistors during transfer from the conveyor to the heat-seal rolls is assured because the free fall has been eliminated. Therefore, transistor leads can no longer be damaged by the heat-seal rolls as the package is sealed.

CONCLUSIONS

Reconstruction of the hand feed packing attachment is nearly complete. Preliminary evaluation of the concept indicates that it will be 100 percent reliable.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete reconstruction.
2. Complete prove-in.
3. Complete shop trial.
4. Complete "Operation and Maintenance Specification".

1.1.13 WAFER SCREENING AND ELECTRICAL PROBE TESTING (2N1072) - P. A. Lajoie

GENERAL

The Wafer Screening and Electrical Probe Testing Machine (2N1072) is similar in its concept and basic design to the 2N1195 Wafer Screening Machine. Bulk 2N1072 wafers will be fed to a pick-up point from a vibratory bowl. Individual wafers will then be picked up by a vacuum needle and placed in a pocket on a rotary index table. Wafers on the tables will be indexed to a photoelectric cell which senses for stripe side "up". If the stripe side is "down", the wafer will be turned over by a flipping mechanism during transfer to a second rotary table. On the second table, the wafers will be indexed under an optical viewer where they are visually inspected and test probes are aligned on the stripes. The wafers will then be automatically tested on two breakdown voltage parameters. Accepted wafers will be transferred to a wafer tray. Rejected wafers will be dropped in a reject bin.

Construction is nearing completion. It continued through the quarter.

ENGINEERING STATUS

Construction of the following subassemblies continued as the quarter began: the flipper mechanism, the main drive assembly, the BV_{EBO} test module, the optical stripe sensing system and the frame. Both the optical stripe sensing system and the frame were subcontracted. The stripe sensing system was received and evaluated early in the quarter. It did not operate reliably, therefore, it was returned for further improvements. Work continues on this subassembly.

The frame was received in mid-August, but final assembly did not start until the latter part of September because work continued on other sub-

assemblies. Part of the frame was dismantled and returned for rework because it did not meet specifications; this did not, however, delay final assembly. Progress on the subassemblies and the machine was slowed by detailed inspection and reworking of parts. Engineering and design changes also hindered progress during this quarter.

Test module construction was completed early in September. Prove-in has not started. The wafer probing mechanism used with the modules has been partially proven-in, but cannot be completely evaluated until test module reliability is established.

A problem was encountered in machining wafer pockets in the rotary tables. A milling operation was used on the first pockets. They were unsatisfactory because they were too irregular and had rounded corners. Hobbing had produced satisfactory wafer pockets in the pickup needles. As a result, it was tried on the rotary tables and satisfactory pockets were made.

CONCLUSIONS

About 45 percent of machine construction was completed this quarter, thus completing about 90 percent of overall construction. Prove-in has not started as expected due to reworking of parts and engineering and design changes. However, the extra precautions taken now should speed prove-in and result in a more reliable machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete construction.
2. Complete prove-in.
3. Complete shop trial.
4. Complete "Operation and Maintenance Specification".

1.1.14 SPECIAL TEST SET (2N1072) - K. C. Whitefield

GENERAL

Construction and post-installation acceptance testing on the Special Test Set (2N1072) were completed in the twelfth quarter. It is a manually loaded, in-line, go no-go testing machine incorporating six D-C and two switching time modules for 2N1072 electrical testing. Its testing rate can be varied from 500 to 1,500 per hour. The test sockets and reject extractors are designed for the TO-38 package of the 2N1072. Test sockets and extractors can be provided so that TO-5 and TO-18 packages can also be tested with a minimum of setup time. Test modules, sequence, biases, and limits can easily be changed, and six spare test stations are available for other test modules.

Shop trial was considered completed with completion of acceptance tests.

ENGINEERING STATUS

During the quarter, drawings and the "Instruction Manual" were revised to cover all changes made during acceptance testing. Due to the nature of the shop trial, an operator has not been trained. Extensive acceptance testing was done by testing 300 2N1072 transistors as follows: 12,000 tests and extractions were made during pre-shipment acceptance testing at the supplier's plant; during the post-installation testing at Laureldale, 30,000 additional tests were made. The post-installation testing is considered to have fulfilled shop trial requirements.

Repeatability of accept-reject decisions was demonstrated to be as specified: less than plus or minus one percent on all D-C tests and within plus or minus four percent on switching time tests. Because the operating temperature and

aging change the characteristics of tubes and other circuit components, it was found most practical to have the test circuits energized continuously and to check and correct for drift weekly - or at longer intervals if checks with the standard transistors so indicated.

Mechanically the machine has been good. The only trouble noted was occasional dropping of rejected transistors on the floor. This problem is attributed to loading test sockets with transistors having excessively distorted leads. However, neither the reject action nor the reject count is affected. The only consequences of this problem are occasional ejection of rejects on the floor and lack of segregation. Avoiding lead distortion or adding a lead straightening operation would eliminate this problem.

Consideration is being given to modifying this machine so that other contracted transistor codes can be tested. This is desirable because mechanized production test equipment is no longer planned for 2N560, 2N1051, and 2N1195 transistors. Machines planned for these codes are scheduled for deletion in a proposed contract modification. Estimates on modifying the machine to increase its versatility are being prepared.

CONCLUSIONS

Satisfactory conclusion of acceptance testing and revision of drawings and the "Instruction Manual" have prepared this machine for production, including maintenance.

Since the machine performed satisfactorily during post-installation acceptance testing, it is considered completed; therefore, this narrative will be deleted in future quarterly reports.

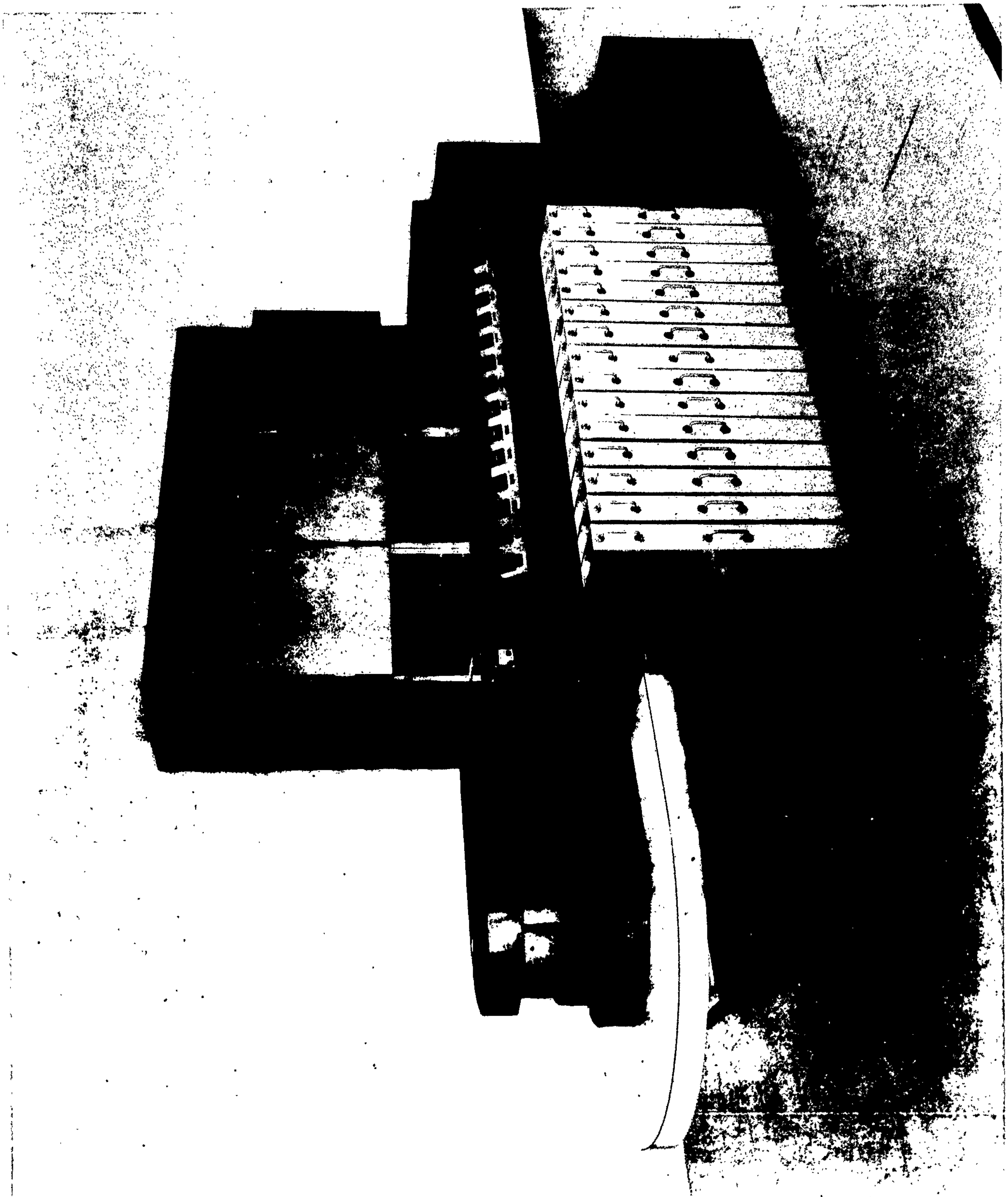


FIGURE 3-2.

SPECIAL TEST SET (2N1072)

1.2 .4 WATT DIODES

This section reviews the progress made during the thirteenth quarter as work continued on incomplete machines for .4 watt diode mechanization. Reports on two completed machines were discontinued in previous quarters. They are:

1. Wafer Preparation
2. Coating

The narrative on Wafer Evaluation has also been deleted even though the machine was not deleted from the contract during the quarter as expected. Deletion of the machine will be proposed next quarter. No further work was done on the machine; it was discontinued in the design phase last quarter.

A total of four machines are now completed. The two following machines were added to the list of completed machines this quarter:

1. Lead Straightening and Racking
2. Coding

Overall progress on mechanization for .4 watt diodes is summarized in the table below. This table lists number of machines in a given phase at the end of the last two quarters. The phase of each machine is determined by the status of its major components. However, if a delinquent component delays machine progress, the phase of that component determines machine status.

Phase	NUMBER OF MACHINES Last Quarter	This Quarter
Completed	2	4
Shop Trial	4	3
Prove-In	4	4
Construction	2	1

Design	2*	2*
Development	0	0

*Deletion of one of these machines is being proposed, and completion of the other is rescheduled for 1963.

The remainder of this section contains reports on incomplete machines as well as machines completed this quarter for high volume production of diodes. These reports briefly describe the operation being mechanized, review work done during the quarter, and status at the end of the quarter.

1.2.1 STUD LEAD CLEANING - H. A. Griesemer

GENERAL

The Stud Lead Cleaning Machine will clean stud lead assemblies as it automatically passes them through three jets of hot nitrogen separated by two sprays of solvent. Stud-leads loaded in racks are placed in the loading station. The racks are then indexed along a track through the cleaning station by an intermittent drive. Finally, they are pushed into an enclosed unloading station.

Prove-in was completed last quarter, but shop trial was delayed because a more conclusive evaluation of the new cleaning process was desired.

ENGINEERING STATUS

Plans were made during August to evaluate the cleaning process. However, since details of the evaluation were not worked out until late in the quarter, the tests were not started.

Effectiveness of the machine's cleaning process will be determined by comparing it with the present manual cleaning process. Stud-leads will be cleaned by both procedures and then gold bonded under controlled conditions. Shear and centrifuge tests will then be made on both groups of gold bonded assemblies to determine comparative strength of bonds and the effectiveness of the cleaning procedure.

CONCLUSIONS

The test devised for checking cleanliness and bondability of cleaned stud-leads should be more conclusive than the water break test used during prove-in.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete shop trial.
2. Install in production area.
3. Write "Operation and Maintenance Specification".

1.2.2 GOLD BONDING - J. E. Beroset

GENERAL

The process to be mechanized is the thermocompression bonding of wafers to miniature diode studs and internal gold leads. It will be performed on the 12-station Gold Bond Machine now in prove-in.

Stud-lead assemblies in handling racks; pre-oriented wafers in tubular magazines, and .006-inch diameter gold wire on spools are the input to the machine. Gold bonded assemblies, again in handling racks, are the output of the machine. The following operations are performed as the indexing table rotates: stud load, stud sense, wafer load, wafer sense; form, cut-off, and load internal gold balled lead; sense gold lead and preheat, thermocompression bond, open nest, unload gold bonded assembly, and purge nest.

Gold bonded assemblies were made for short periods at the designed rate as prove-in continued this quarter. Prove-in cannot be completed until the new wafer loading station is added.

ENGINEERING STATUS

Design of the wafer loading station was completed during the quarter, and construction was started. The bonding which was done required manual wafer loading; therefore, the maximum bonding rate could only be maintained for short intervals due to operator fatigue. After installation of the automatic wafer loading station, continuous operation will be possible.

Before bonding at the maximum rate was possible, several prove-in modifications were completed earlier in the quarter to increase the machine's reliability. They included the following: the new rack handling system, the

new stud-lead locating mechanism, and 12 new bonding nest assemblies. Prove-in was delayed as the quarter began because these subassemblies were under construction.

After completing construction, installation, and prove-in of the modified subassemblies, the machine's maximum bonding rate was attained while manually loading wafers. Bonds made with the 12 new nest assemblies have been good; installation of the stud-lead locating mechanism has virtually eliminated stud-lead loading problems.

Close concentricity of the gold wire, wafer, and stud is presently attained by accurate, manual alignment of the nest assemblies. This method has been quite laborious, hence an optical alignment method was developed to permit rapid, yet accurate, visual alignment of the nest assemblies. The optical nest alignment fixture is being constructed with construction about 75 percent completed as the quarter ended.

CONCLUSIONS

Prove-in modifications completed have increased the machine's reliability and permitted bonding at the maximum design rate for short intervals. Continuous operation at this rate cannot be accomplished, however, until the automatic wafer loading station is completed and installed. Prove-in is now about 80 percent completed.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete prove-in and shop trial.
2. Install in production area.
3. Complete "Operation and Maintenance Specification".

1.2.3 ETCHING, OXIDIZING, CLEANING AND DRYING - D. M. Large

GENERAL

The Etching, Oxidizing, Cleaning and Drying process to be mechanized is the cleaning and controlled cleanup etching of exposed semiconductor junction, application of a protective oxide coating, and oven drying of gold bonded diode assemblies prior to electrical testing. These operations are performed as follows:

Handling racks containing gold bonded assemblies are transferred from a tray to a machine magazine and placed on a carriage in the loading station. The magazine is automatically transported through five stations: etching, oxidizing, deionized water rinse, ultrasonic deionized water rinse, and acetone dip. Processed assemblies are removed at the unload station and placed into an oven for drying prior to electrical testing.

Installation and prove-in were completed this quarter. Shop trial has been started.

ENGINEERING STATUS

The following work was done early in the quarter, before process prove-in was started:

1. Drying oven was installed and proven-in.
2. An acetone handling system was installed and proven-in.
3. Water rinsing facilities were installed.
4. A protective PVC pad was installed under the machine.
5. Explosion proof electrical seals were poured.
6. Strainers were installed on the acid pumps.

Since initial leak tests of the liquid handling systems were made with water, additional leaks appeared once acids were placed in the systems. These leaks occurred at the threaded pump connections. (Threaded connections were used to make pump maintenance easier.) Except for one pump having a body made of "Teflon", leaks were stopped by solvent welding the PVC connections at the pumps. Stainless steel hose clamps were placed over the inlet and outlet hubs of the pump body made of "Teflon" to decrease stresses on the threads after the PVC piping was tightened enough to stop the leaks.

Several pump liners broke during initial prove-in, thus causing acid leaks. Faulty liners, loose pump block tie bolts, and absence of strainers at acid pump inputs combined to cause failure of the liners. These leaks corroded the seals, bearings and cover plate of the etchant mixing pump.

Acid fumes from the leaking pumps also caused heavy corrosion in the load and unload stations. The parts will have to be cleaned and painted with acid resistant paint or be remade of stainless steel. Use of acid also led to solvent welding the protective housing for the temperature sensing elements in the refrigerated acid supply tanks. This was necessary to prevent acid seepage and attack of the sensing elements.

Process prove-in was completed by processing several small lots, totaling approximately 200 gold bonded assemblies. The assemblies were then curve traced and data recorded. Results were comparable to normal production. Shop trial has not progressed far enough to report results. However, plans have been made to conduct a controlled experiment.

CONCLUSIONS

Shop trial was started but not completed this quarter, as forecast.

Installation took longer than expected, and the problems caused by acid leaks and fumes led to further delays. While prove-in results were comparable to normal shop yields, a few more small lots should be processed to optimize process times and liquid flow before conducting a controlled experiment with larger quantities of diodes.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete shop trial.
2. Complete "Operation and Maintenance Specification".

1.2.4 ASSEMBLING CASE TO STUD AND WELDING - C. R. Fegley

GENERAL

The Assembling Case to Stud and Welding Machine will automatically assemble and weld the stud-lead-wafer assembly to the tubulated can. It consists of eight stations: rack input, internal lead straightening, can loading, assembly, pick-up, welding, discharge, and rack output. Etched stud-lead-wafer assemblies and tubulated cans are fed into the machine. After processing through the machine welded assemblies are placed in the same aluminum trays in which the assemblies were received.

Prove-in continued through this quarter. The problem at the assembly station has been eliminated by installing a newly designed assembly station. Several other minor improvements brought the efficiency of the machine to approximately 60 percent. Problems still exist in indexing, and in pickup and discharge at the welding station.

ENGINEERING STATUS

The case handling and tack-welding portions of the assembly station were redesigned, installed and proved-in. During the redesign of the assembly station, a new, more positive method of threading the internal lead into the tubulation was devised. It will be installed if the present threading method proves unsatisfactory. The new assembly station will, with good product, assemble 100 percent of the cases and studs. It will also thread approximately 97 percent of the internal leads. The three percent failures are due to two problems:

1. Bends in the internal lead.
2. Bends in the external stud-lead.

The need for dimpled cans has been eliminated by the addition of the new tack-welding station. With this station, it is now possible to accurately control the tack-welding pressure, thereby eliniating all tack-welding problems.

Several other changes have been made to the machine, such as improving the internal lead straightening station, reworking the funnel, and improving the rack output station. As noted above, the lead straightening station is still not as reliable as desired. The following three problems have prevented improvement of machine efficiency beyond the present 60 percent:

1. Erratic rack indexing: the three rack indexing stations are designed for an exact index of .25-inch with no over-travel allowance.. Several limitations were imposed by the indexing method chosen. To index a rack, the indexing fingers straddle the stud-lead and engage countersunk holes in the rack which are designed to index the rack as well as guide stud-leads into the rack. This indexing method did not provide the precise, positive index required; as a result two problems developed: jam-ups occurred at track loading station when a rack was not indexed completely clear of the station; at other times, stud-lead assemblies were either destroyed by the three indexing fingers or misaligned by the fingers so malfunctions occurred at succeeding stations. These problems occurred whenever the indexing fingers did not seat properly or occasionally could not seat. The jam-ups at the loading station resulted because racks had to be loaded into the track with very little, or no clearance, in order to assure proper indexing. Failure to index a rack immediately after

loading the track leads to a serious assembly station malfunction just before the rack reaches the assembly station.

2. Malfunctions at the loading station of the ring welder: to load a tack-welded assembly into the ring welder, the assembly must be raised one-half inch so that the loading head can pick it up. Two ramps were designed to raise the assembly as the racks are indexed along the track: One ramp cams up the assembly by working on the flange; the other ramp, below the stud-leads, was designed to aid in camming and to hold the assembly in its raised position. This method of raising the assembly causes bent leads and occasional malfunctions. The malfunctions occur whenever the end of the lead is bent in such a way that the racks are jammed in the track. As a result of this jam-up, the indexing mechanisms are either jammed or assemblies are damaged as the indexing fingers are forced out of the indexing recesses. The loading head for the ring welder will load moderately bent leads. Etched assemblies supplied for prove-in, however, were so badly bent that the loading head could not load the ring welder reliably. Bent leads, however, will not be a problem once units are received from preceding mechanized operations.

3. Insufficient clearance at the unloading station of the ring welder was provided for the "up" and "down" strokes of the unloading mechanism. Eliminating this problem requires changes in cams and cutting additional clearance.

CONCLUSIONS

Prove-in efforts, during the thirteenth quarter, have increased machine

efficiency from approximately 25 to 60 percent. Additional increases will be made once the foregoing problems are corrected.

OBJECTIVES FOR THE NEXT QUARTER

1. Correct remaining problems and complete prove-in.
2. Complete concurrent shop trial.
3. Install in production area.
4. Write "Operation and Maintenance Specification".

1.2.5 LEAD STRAIGHTENING AND RACKING - W. A. Schlemm

GENERAL

The process to be mechanized is the straightening of .4 watt diode leads and the racking of straightened diodes. Loaded racks are stacked in magazines for transportation to the next machine.

An operator feeds 48 diodes into the input chute of the machine. As the diodes pass through the machine, the leads are straightened by a rolling action. The diodes are then transferred to the racking station, which automatically indexes racks through it.

Empty racks are placed in the starting position on the racking station by the operator after they are released from the bottom of a magazine. Loaded racks are also placed under a second magazine by the operator. By pushing two buttons, electrically in series, the loaded rack is pushed up into the magazine; at the same time, another empty rack is released from the bottom of the other magazine.

Shop trial was completed by running 50,000 diodes through the machine. These diodes were then processed through the Final Electrical Testing Machine. (See the completed machine in Figure 3-3.)

ENGINEERING STATUS

Shop trial was completed without moving the machine from the prove-in area. Results obtained approximated earlier evaluations of roller versus die straightening. The rolling principle has been thoroughly proven since completing the evaluation on another straightening machine by successfully processing over 2,000,000 diodes.

During shop trial, the machine efficiency was 99.48 percent. This was 0.17 percent lower than the 99.65 percent realized during the feasibility study of roller straightening. During the feasibility study, bends were confined within a one-half inch diameter cylinder, since this degree of bend was selected as the sharpest bend the straightening machine will "see" on the mechanized line. During shop trial, the operations preceding Lead Straightening and Racking were not completely mechanized; therefore, the leads were more severely bent than should be normal on the mechanized line. The straightening machine is built to straighten more severely bent leads, but the pick-off system and the entrance to the straightening shoe tend to damage more diodes when the leads are severely bent.

Due to the simplicity of the machine, operator training was no problem. The only problem which recurred was loading of 47 instead of 48 diodes on the racks. This happened whenever the operator was slow in presenting diodes to the machine. Here again, the condition of the leads was the controlling factor. In the mechanized line, the lead condition should be better. Minor adjustments corrected two other problems: Rack indexing was "smoothed out" by adjusting flow controls, and the straightening shoe was adjusted when one lead was not straightened to specification. The shoe adjustment will be required periodically.

CONCLUSIONS

Shop trial runs have been completed. The machine should be installed in the manufacturing shop in October. Future quarterly reports will delete this narrative, since the machine is complete.

OBJECTIVES FOR THE NEXT QUARTER

1. Install in production area.

2. Complete "Operation and Maintenance Specification".

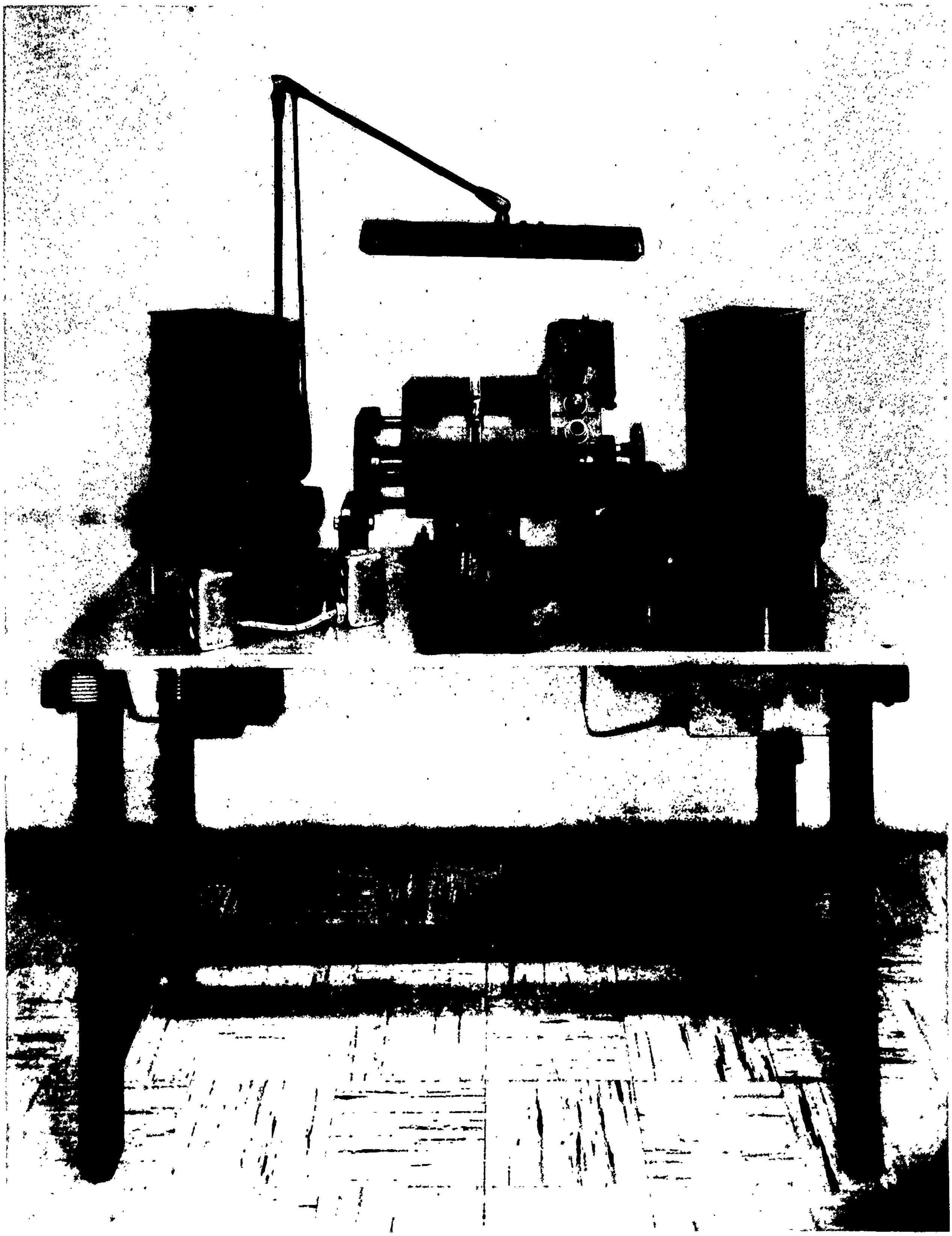


FIGURE 3-3.

.4 WATT LEAD STRAIGHTENING AND RACKING MACHINE

1.2.6 LOW TEMPERATURE REVERSE CURRENT AND SHOCK TESTING - H. A. Griesemer

GENERAL

The Low Temperature Reverse Current Testing Machine will monitor the reverse current as diodes are cooled from ambient to a specified low temperature. Testing will be performed after inserting a test fixture containing two material handling racks, holding 24 diodes each, into a mechanical refrigerator through a slot in the side. Electrical contact will be made simultaneously with all diodes contained in the contact fixture. Each diode will have a separate test circuit; failure of a particular diode will be indicated by switching "off" a numbered light corresponding to the test position of the diode.

The Low Temperature Shock Test was deleted from the machine in the tenth quarter. Construction of the Low Temperature Reverse Current Testing Machine is complete and prove-in is in progress.

ENGINEERING STATUS

Only minor construction details remained as the quarter began. They were completed concurrent with prove-in. Prove-in tests indicated several operating problems which have been or are being corrected.

Flooding the contact fixture with dry air did not prevent the formation of frost as expected. To eliminate frost formation, dry air will now be directed on the various surfaces at a higher velocity. Two manifolds having four outlets each will be provided to do this. In addition, it was found that operating the refrigerator at higher temperatures provides a higher ratio of time-out of the refrigerator to time-in. This maintains a higher average fixture temperature and helps prevent formation of frost.

Prove-in tests indicated that the temperature sensing diode and circuit perform satisfactorily. Diodes being tested are cooled to the anticipated minimum temperature in 40 to 60 seconds. During these prove-in tests, difficulty was experienced in returning the temperature sensing diode to room temperature after each test. It was accomplished initially by controlling the air flow and heating the diode with a microscope illuminator. Since this method left little margin of safety, a separate air line containing a heater will be installed. Air temperature will be controlled by varying the air flow.

Two changes were needed on the contact fixture. One was made to obtain reliable contact with the diode. It was accomplished by lowering the contact block thus increasing the contact pressure. Spring loaded plungers will be added to the fixture to hold it fully open during loading and unloading. This will facilitate loading and unloading, and minimize bending of leads.

A number of changes to the test set circuitry were found necessary.

1. The regulated 200 and 250 volt power supplies were redesigned to provide more reliable operation.
2. A new transformer was added to increase the intensity of the indicating lights.
3. The continuity checking circuit was redesigned to obtain positive resetting of "Sensitrol" relays after the continuity check. Resetting of the "Sensitrol" relays sets up the current monitoring circuit.
4. A light was added on the control panel to indicate start of the test cycle.

5. A remote voltage control network was designed and installed to provide a voltage control for the operator.

CONCLUSIONS

Construction of the Low Temperature Reverse Current Testing Machine was completed this quarter. Prove-in is 60 percent complete, and shop trial has started.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete prove-in and shop trial.
2. Install in production area.
3. Complete "Operation and Maintenance Specification".

1.2.7 GOLD PLATING - H. C. Grunewald

GENERAL

The Gold Plating operation to be mechanized is the cleaning of .4 watt diode assemblies and the application of electroless gold plate to the cleaned assemblies prior to Coding. The cleaning and plating operations are performed with handling fixtures which are manually processed through seven tanks housed under two PVC hooded sinks.

ENGINEERING STATUS

During the quarter ending September 26, 1962, the four remaining handling fixtures were completed. Construction of the over-all plating system was nearing completion and installation of the system on the production line was about to start. Construction was held up for several weeks during this period because of raw material supply difficulties and because of a sub-contractor's problems in meeting fabrication schedules.

CONCLUSIONS

Construction of the Gold Plating system continues now without difficulty as tanks and drains are being welded and water heater connections are being fabricated.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete construction and installation.
2. Complete prove-in.
3. Complete shop trial.
4. Complete "Operation and Maintenance Specification".

1.2.8 CODING - D. M. Large

GENERAL

The Coding Machine will mechanize the application of code markings to the body of .4 watt diodes and the racking of the coded diodes for oven drying and subsequent Coating. Code markings consist of letters, numbers, and a diode symbol. It performs this operation as follows:

> Twenty-four diodes in a handling rack are simultaneously loaded by manually placing them in a comb at the loading station. After the rack is withdrawn, the diodes fall onto a chain which conveys them to the coding wheel. Coded diodes are then dropped down a vertical track to the racking station where they enter notches of aluminum handling racks. These racks are automatically transferred from one magazine to another.

Shop trial has been completed. An overall view of the machine is shown in Figure 3-4.

ENGINEERING STATUS

The new photelectric sensing system, mentioned in the previous report, has been installed and prove-in. It is very reliable. If a pile-up occurs at the racking station, it is detected by the photoelectric cell and the machine is stopped.

During the quarter, the need for an inspection station was revealed. Shop trial was temporarily stopped so that this station could be added. Due to the construction of the machine, no means of inspecting the code markings was readily available. To provide an inspection station, sections of the side and the base plate were cut away. It was necessary to dis-assemble the

machine so that the base plate could be removed for cutting. While the machine was dis-assembled, several temporary parts added during prove-in were removed and replaced with permanent parts. The machine was re-assembled and shop trial was completed. No further problems were encountered.

Necessary spare parts have been purchased and stocked.

CONCLUSIONS

During shop trial approximately 15,000 diodes were coded by the machine. Samples were periodically taken and visually inspected for contrast, legibility and location of code markings. The quality of coding was as good as or slightly better than on manually coded diodes. The reason for better coding is more consistent loading and location of the diodes on the Coding Machine.

Since the machine is now completed and is operating satisfactorily, future quarterly reports will delete this narrative.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete "Operation and Maintenance Specification".

FIGURE 3-4.

.4 WATT DIODE CODING MACHINE

1.2.9 FINAL ELECTRICAL TESTING (1N673-1N675-1N697 & 1N810) -

P. F. Fundinger

GENERAL

The Final Electrical Testing Machine conveys good .4 watt diodes from magazines and handling racks, through the testing stations, to the unloading station where it placed them in other handling racks. It also segregates and ejects rejected diodes according to the test failed.

Aluminum handing racks are removed from the magazine by a pneumatically operated mechanism which is electrically interlocked with the indexing cycle. A loading plunger loads the diodes one at a time into carriers. The carriers mounted on the indexing conveyors are accurately positioned above the loading plunger by a locator pin which is activated an instant before loading takes place.

Four-point contact is made with the diode in the carriers. It is not broken until the diode is accepted or rejected. Due to the in-line conveyor system, up to nine different parameters can be checked simultaneously. Test parameters are programmed according to codes and set up by a single selector switch. To assure good contact, a detecting station precedes the test stations. If contact is poor, the diodes are ejected into a bin for reloading and retesting. Electrical circuitry is self-checking. The interval of self-checking can be varied from zero to twelve hours. Failure of a test circuit stops the machine. An indicator light indicates the faulty module.

Construction of the unloading station is complete. It will be installed during October. Some changes, which proved necessary on an identical station of the Gold Bonding Machine, will be incorporated during prove-in. Prove-in of the test set is continuing.

ENGINEERING STATUS

As prove-in continued, several problems were corrected: Relay breakdowns caused by high inductive loads from the segregation solenoids were discovered, and protective circuit changes were made. All test clamps had to be reworked to keep the contact resistance below one ohm. New clamp springs were also designed and installed to reduce bending stresses on the diode while loading and unloading the clamps.

Final check-out of all modules is progressing and should be finished by mid-October. The check-out is being done with precision resistors. It would be more desirable to use diodes; however, since sufficient diodes having borderline values were not available, this was not possible.

The breakdown voltage testing problem mentioned last quarter was not resolved as the quarter ended.

CONCLUSIONS

Approximately two weeks of prove-in will be required for the unloading station once it is installed in October. However, this will not delay prove-in and shop trial of the machine itself. Accepted diodes can be collected at the last test station since it is a spare.

An operator has been trained.

Final correlation test data will be collected as soon as the check-out is complete in the first half of October, 1962.

OBJECTIVES FOR THE NEXT QUARTER

1. Install and prove-in unloading stations.
2. Complete prove-in.

3. Install machine in production area.

4. Complete shop trial.

5. Complete "Operation and Maintenance Specification".

1.2.10 PACKAGING - F. E. Tweed

GENERAL

The Packaging process to be mechanized is the simultaneous insertion of 24 completed .4 watt diodes into styrofoam block. The blocks can be loaded directly into a cardboard box or into an aluminum storage tray.

The machine receives diodes in handling racks, containing 24 diodes each, and styrofoam blocks. The packaging cycle starts when a handling rack is automatically transferred from the loading station into the elevator station. This station removes the diodes from the handling racks and loads them into styrofoam blocks. After the diodes are removed from the handling racks, they are pushed out of the elevator by the styrofoam block entering. Then, the diodes are loaded into the styrofoam block, and the loaded block is pushed into the block unloading station by the next handling rack entering the elevator station.

Construction and prove-in were completed during the previous quarter. The machine has been installed in the production area this quarter, but shop trial has not begun.

ENGINEERING STATUS

The Packaging Machine was installed in the production area at the beginning of the quarter. After installation, a check was made to insure that it operated satisfactorily. While running the machine, considerable trouble was encountered with the styrofoam block loading in the elevator station.

An investigation revealed that the width of the styrofoam blocks exceeded original predictions. Thus, whenever a block was too wide, it was compressed

while being pushed into the elevator station and was not positioned properly. As a result of the compression, the block could not push the unloaded handling rack completely out of the elevator. Then, as the elevator moved upwards to load the styrofoam block, the handling rack jammed and stopped the machine.

To overcome this problem, the guides and elevator openings for the styrofoam blocks were widened to provide free movement of the blocks, and the leads on all guide corners were lengthened and widened to reduce friction and interference. Further tests indicated that these changes overcame the problem.

CONCLUSIONS

Modifications made this quarter have eliminated a source of trouble during shop trial and, therefore, increased the reliability of the machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete shop trial.
2. Complete "operation and Maintenance Specification".

1.2.11 DATA PRODUCING TEST SET - J. E. Beroset

GENERAL

The Data Producing Test Set will mechanize sample testing of .4 watt diodes and recording of test data on punched tape or punched cards. This test data will be presented to a computer where it will be processed for quality control, production control, and engineering analysis.

ENGINEERING STATUS

Due to testing limitations imposed by test equipment proposed by subcontractors, the decision was made to internally design and build the test equipment. A new schedule has not yet been determined; however, a proposal to modify the contract will propose completion of the Data Producing Test Set during 1963.

Design of the test set has been initiated. The test set concept consists of a control and sequencing module and individual modules for testing the following parameters:

Saturation current	I_S
Breakdown voltage	BV
Forward voltage	V_F
Breakdown impedence	bz
Capacitance	C
Forward impedence	z_f
Reverse recovery time	t_{rr}

Programming, bias conditions, and parameter limits are readily programmable by inserting plug-in circuits.

CONCLUSIONS

Because of testing limitations imposed by proposed commercial test equipment, the Data Producing Test Set will be designed and built internally. As a result, the completion date will need to be extended.

OBJECTIVES FOR THE NEXT QUARTER

1. Continue design.
2. Establish new completion schedule.

2. CONTRACT MODIFICATION - H. J. Huber

During the thirteenth quarter, the Western Electric Company continued its preparation of the proposed contract modification based on the latest semiconductor technological advancements and on the current Government planning for the Nike Zeus production requirements of the subject contract devices.

As a result of additional technical discussions during this quarter between representatives of the U. S. Army Electronics Materiel Agency and the Western Electric Company, further revisions were made to the scope of the proposed contract modification which extended the preparation of the proposal beyond this report period. Therefore, submission of the proposed contract modification to the U. S. Army Electronics Materiel Agency, which had been previously scheduled for this quarter, will be made during the forthcoming quarter.

3. SPECIAL STUDY - SAMPLE ASSEMBLY OF D-C AND SWITCH TESTING MACHINE (2N560-2N1051) - E. Sirianni

GENERAL

This special study covers one phase of the development work done for the D-C and Switch Testing Machine (2N560-2N1051). It was undertaken to evaluate the sample assembly of the machine shown in Figure 3-5. Previous development of a side-entry test socket and contact assembly led to construction of this assembly. In addition to the side-entry test socket and contact assembly, the sample assembly has the following features: a track for magnetic handling trays; a loading mechanism; a trimming station; two testing stations, and a reject mechanism.

Electrical characteristics of the test sockets and contact assemblies developed were checked on five parameters. Both correlation and repeatability were good.

SIDE-ENTRY TEST SOCKET AND CONTACT ASSEMBLY

The side-entry test socket and contact assembly were developed so that transistors could be transferred laterally from handling trays into the D-C and Switch Testing Machine (2N560-2N1051). This test socket is made of epoxy plastic reinforced with glass fiber. Three slots cut into the side of a plastic block provide for side-entry of the leads. Three access holes are also provided in the slots so that prongs of the contact assembly can engage the transistor leads in the test socket.

The body of the contact assembly is made of "Teflon". The "Teflon" supports three individually spring-loaded contact prongs which can be attached to the output of various test modules.

HANDLING OF TRANSISTORS

Input to the sample assembly was the same as planned for the D-C and Switch Testing Machine. It consisted of a magnetic handling tray loaded with transistors. The tray maintains proper transistor orientation during handling and processing. An indexing mechanism indexes the tray along the track to the loading mechanism. Figure 3-6 shows a tray loaded with transistors positioned for pickup by the loading mechanism.

LOADING MECHANISM

The loading mechanism transfers the transistors from the magnetic tray into the side-entry test socket. The cylindrical loading head on the mechanism contains a magnet which holds the transistor during transfer. A slot in the cylinder orients the transistor by engaging the tab on the header. After the transistor is engaged by the loading head, it is pushed out of the magnetic tray toward the side-entry test socket. (A view of a transistor in transit is shown in Figure 3-6.) When the transistor reaches the test socket, it is pushed into the side-entry slots and held in position by a spring clip. After the loading head is lifted vertically, the loading mechanism returns to the loading nest. Then the loading cycle is completed, and the loaded test socket can be indexed to the trimming station.

LEAD TRIMMING

At the trimming station, the leads are trimmed to the specified length without removing transistors from the test socket. Two jaws clamp that portion of the leads extending below the test socket before the cutting blade is activated. This blade is located below the clamping jaws. Figure 3-7 shows the lead trimming station with the leads held in the clamp. After

the lead are trimmed and released by the jaws, the transistor is ready for its first electrical test.

TESTING STATIONS

At the testing stations, the contact assembly engages the leads in the test socket. It is mounted on the follower of a positive-action cam which moves it into the test position. Figure 3-8 shows a contact assembly wired for a switching time test. Various electrical components can be mounted near the contact assembly as shown in Figure 3-8.

Two testing stations were provided on the sample assembly: One was used for switching time tests; the other, for the following D-C tests: BV_{CEO}, BV_{EBO}, V_{CE}, V_{BE}, and I_{CBO}. Good contact pressure and low contact resistance is obtained at the point of contact by a wiping-wedging action of the contact prongs on the leads. Contact resistance measurements, between the contact assembly and the transistor leads, of .002 to .006 ohms were made in the laboratory. Repeatability tests made on sample transistors over a three week period also indicate that good contact is made. These test results are shown graphically in Figures 3-10 to 3-14.

REJECT MECHANISM

The reject mechanism consists of the spring clip holding the transistor in the test socket; a lead ejector at the bottom of the test socket; an accept solenoid, and a reject plunger. In Figure 3-9, the accept position is shown by the left-hand socket. On the right-hand side a transistor has been ejected. Both the spring clip and the lead ejector are in the forward position. Note the position of the reject plungers at the rear of the socket assembly: The left-hand one is "up" in the accept position, and the

right-hand plunger is "down" in the reject position. With the plunger down, transistors are ejected by a camming action as the table is indexed to the next station.

Fail-safe rejection is provided because all transistors will be rejected unless the accept solenoid is energized. The "accept" or raised position of the reject plunger is obtained by operating a D-C solenoid located directly beneath the reject plunger. A given solenoid is energized whenever it receives an accept signal from the test module. If a transistor fails a test, the solenoid is not energized and the reject mechanism remains in the reject position.

CONCLUSIONS

The sample assembly of the D-C and Switch Testing Machine (2N560-2N1051) was proven-in successfully with only minor changes required. Results of switching time and D-C tests showed that both good correlation and repeatability were obtained with the side-entry test socket developed for the machine.

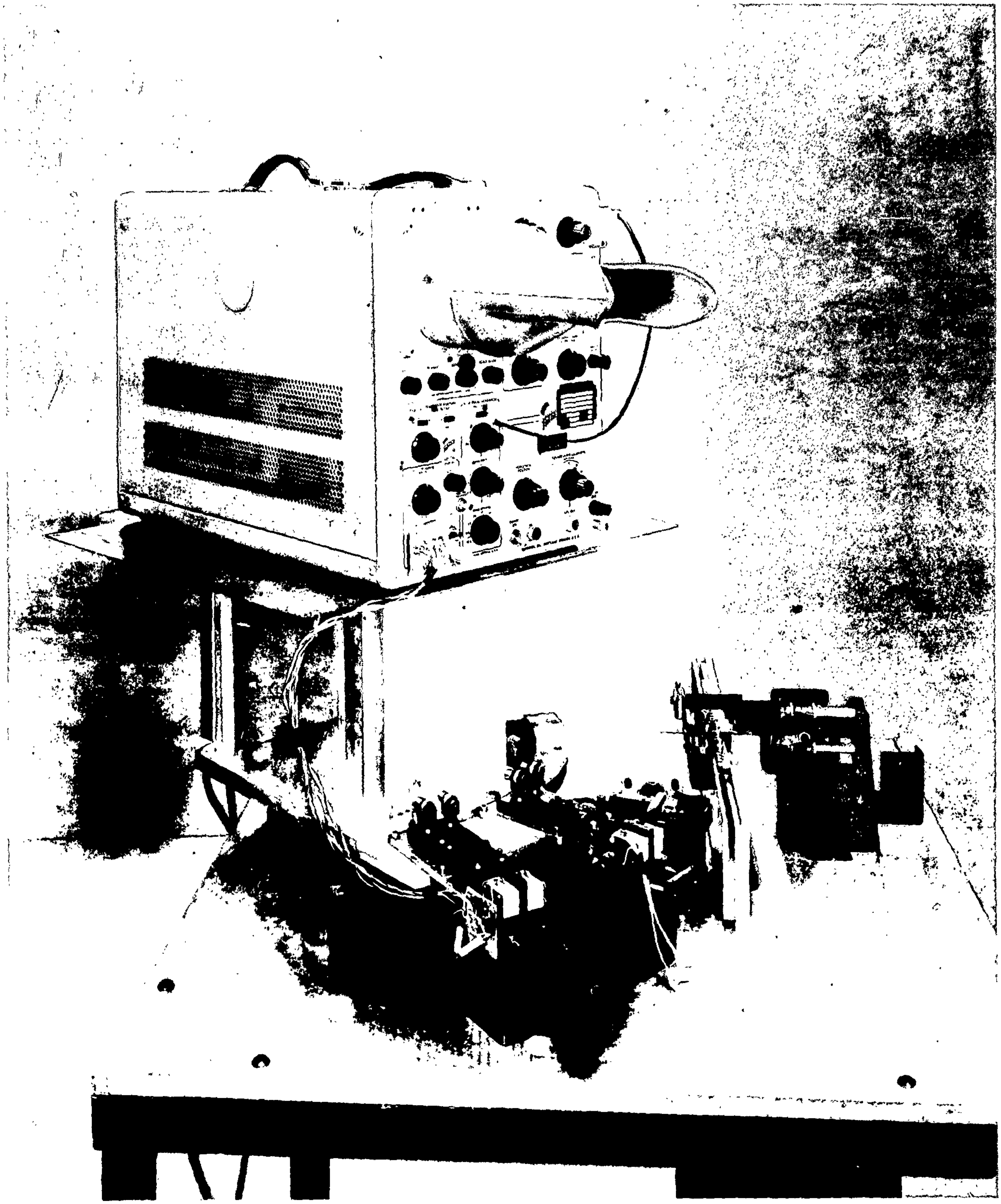


FIGURE 3-5.

SAMPLE ASSEMBLY OF THE D-D AND SWITCH TESTING MACHINE (2N560-2N1051)

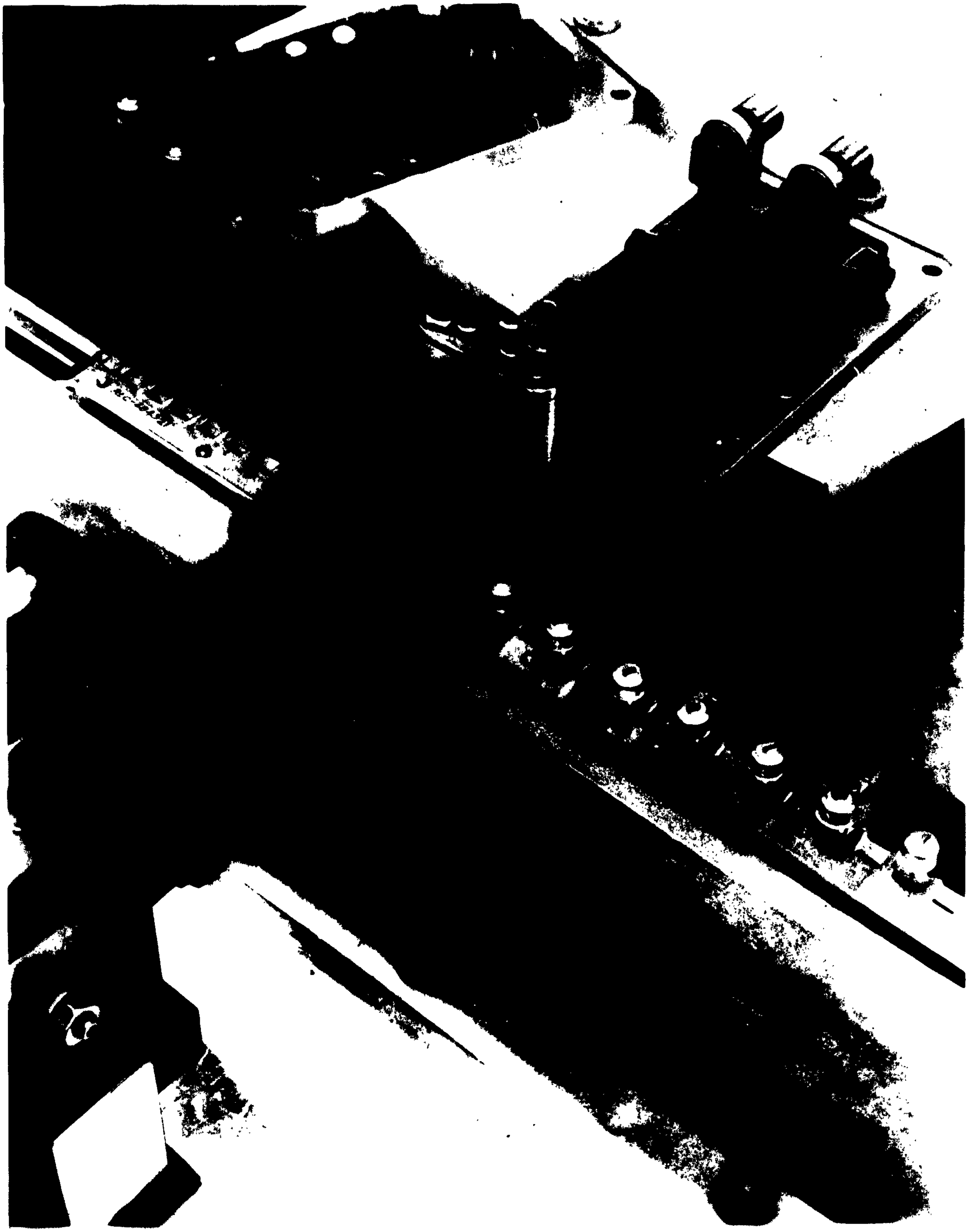


FIGURE 3-6.

LOADING MECHANISM OF THE SAMPLE ASSEMBLY

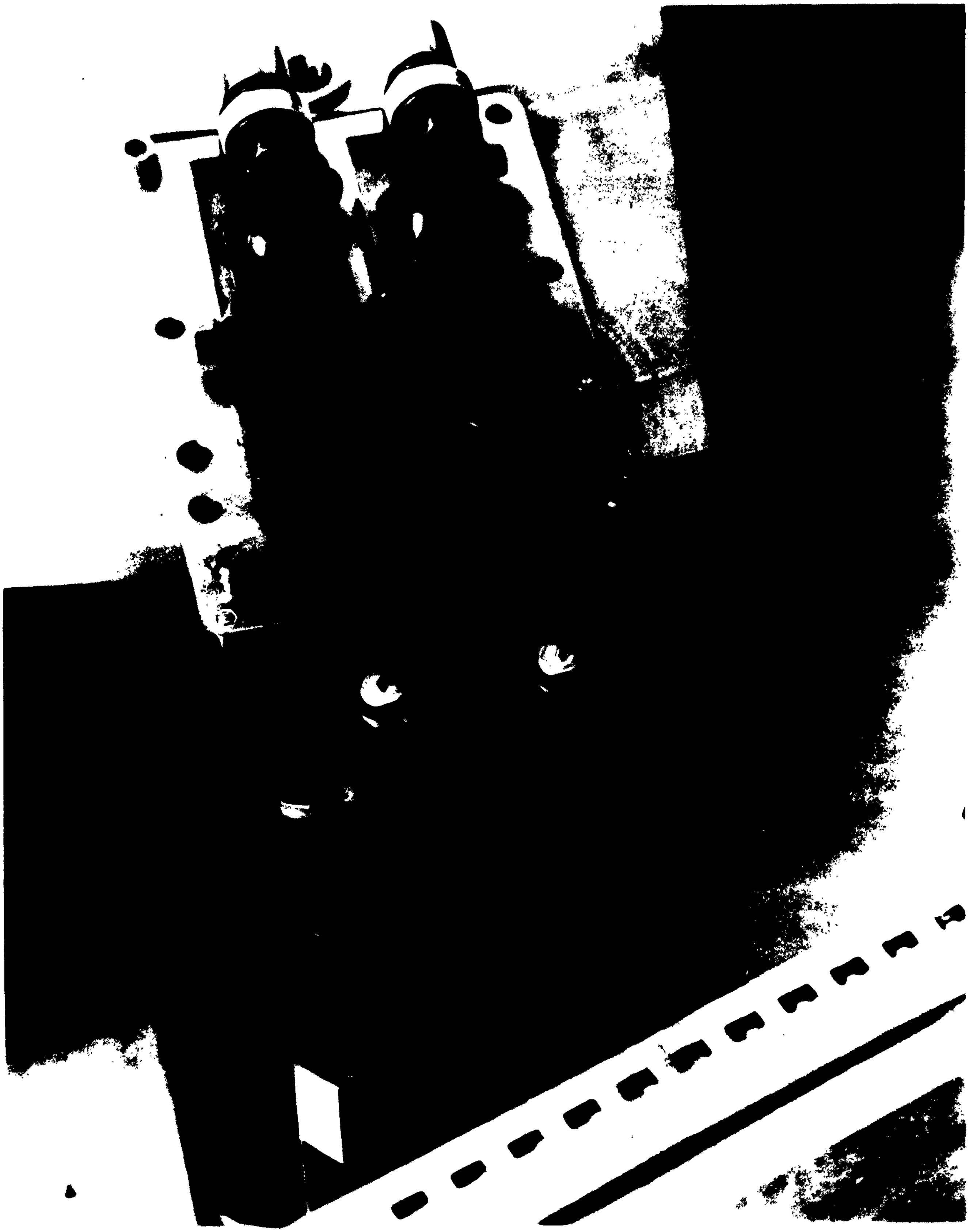


FIGURE 3-7.

LEAD TRIMMING ON THE SAMPLE ASSEMBLY

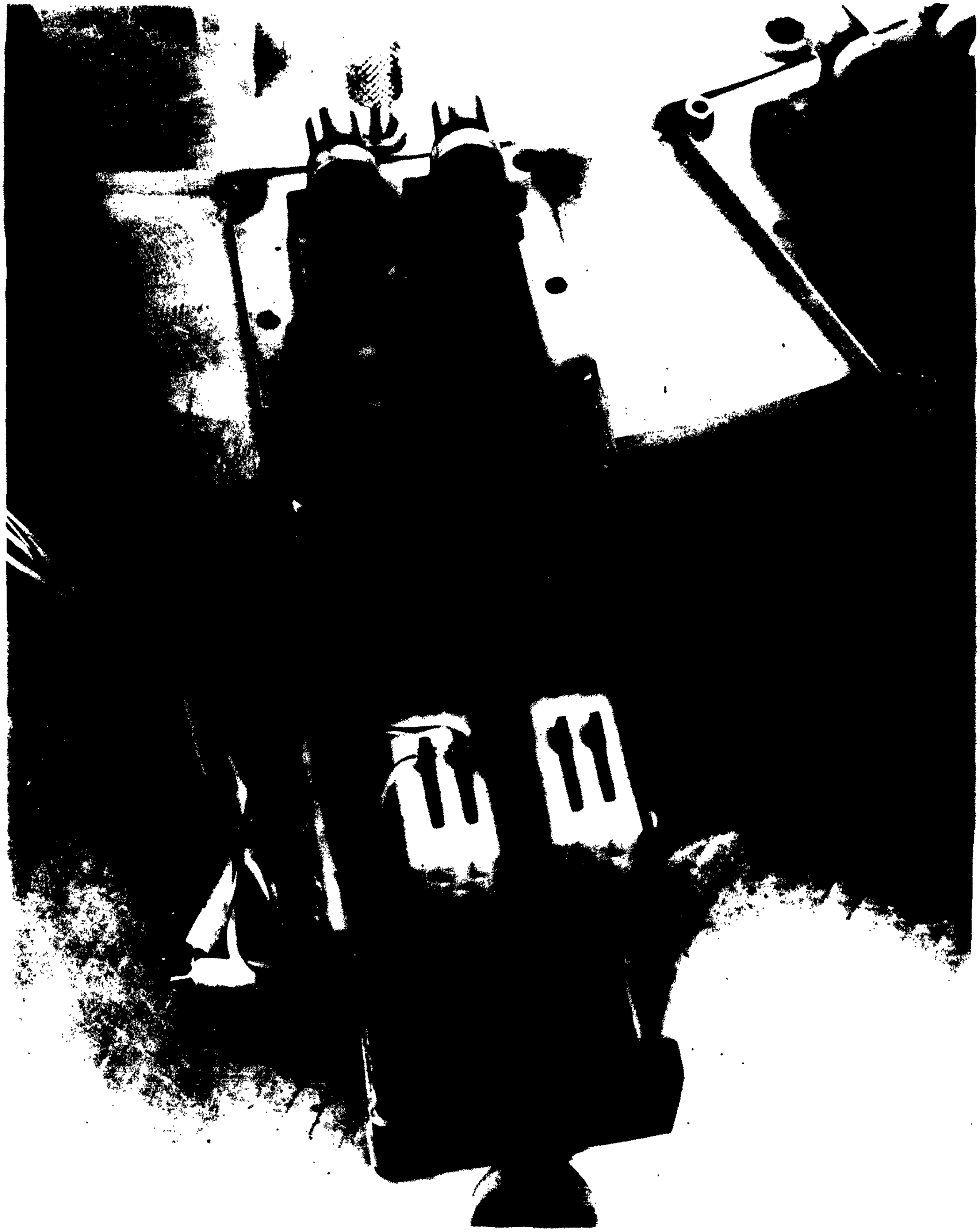


FIGURE 3-8.

SWITCHING TIME TEST STATION OF SAMPLE ASSEMBLY

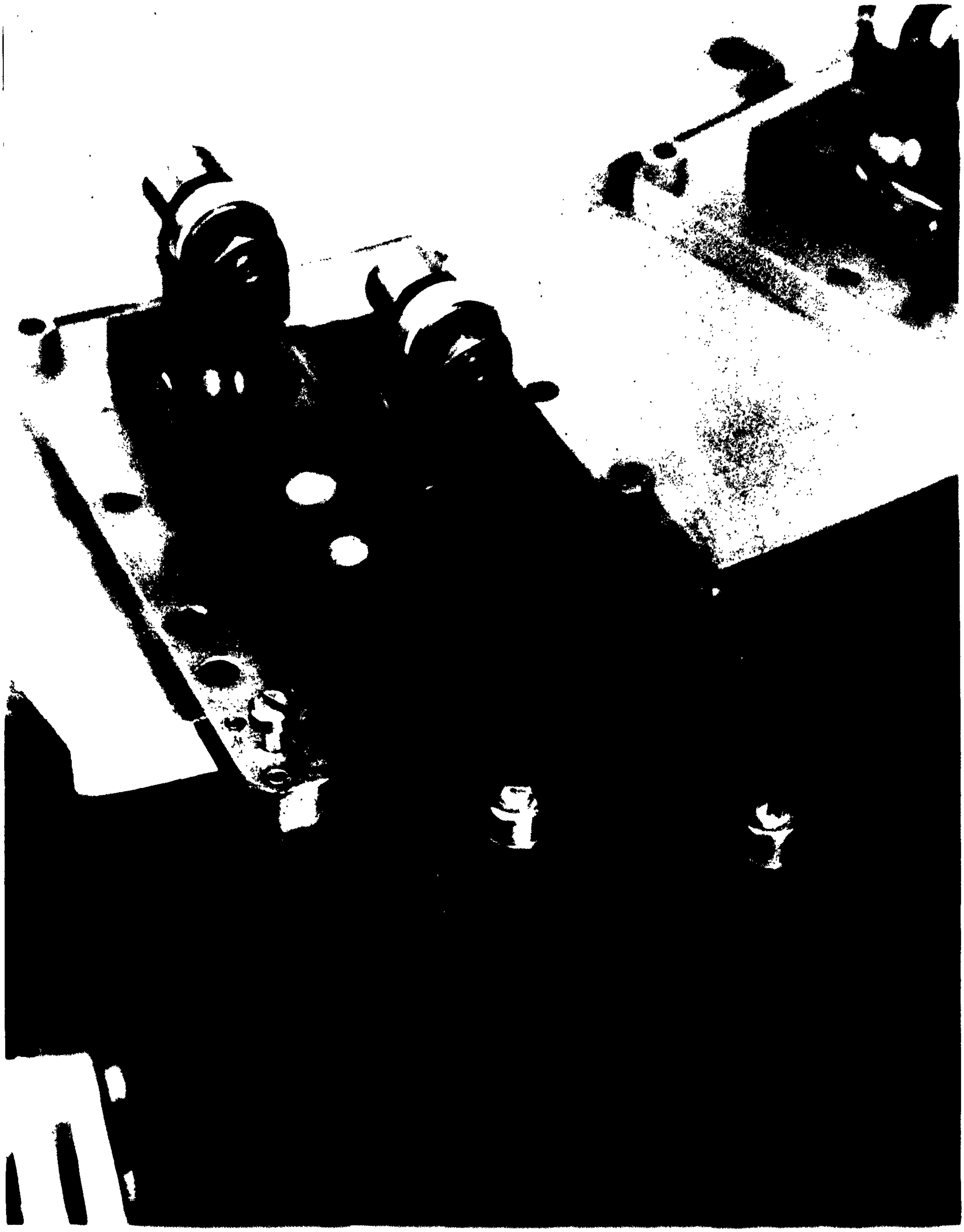
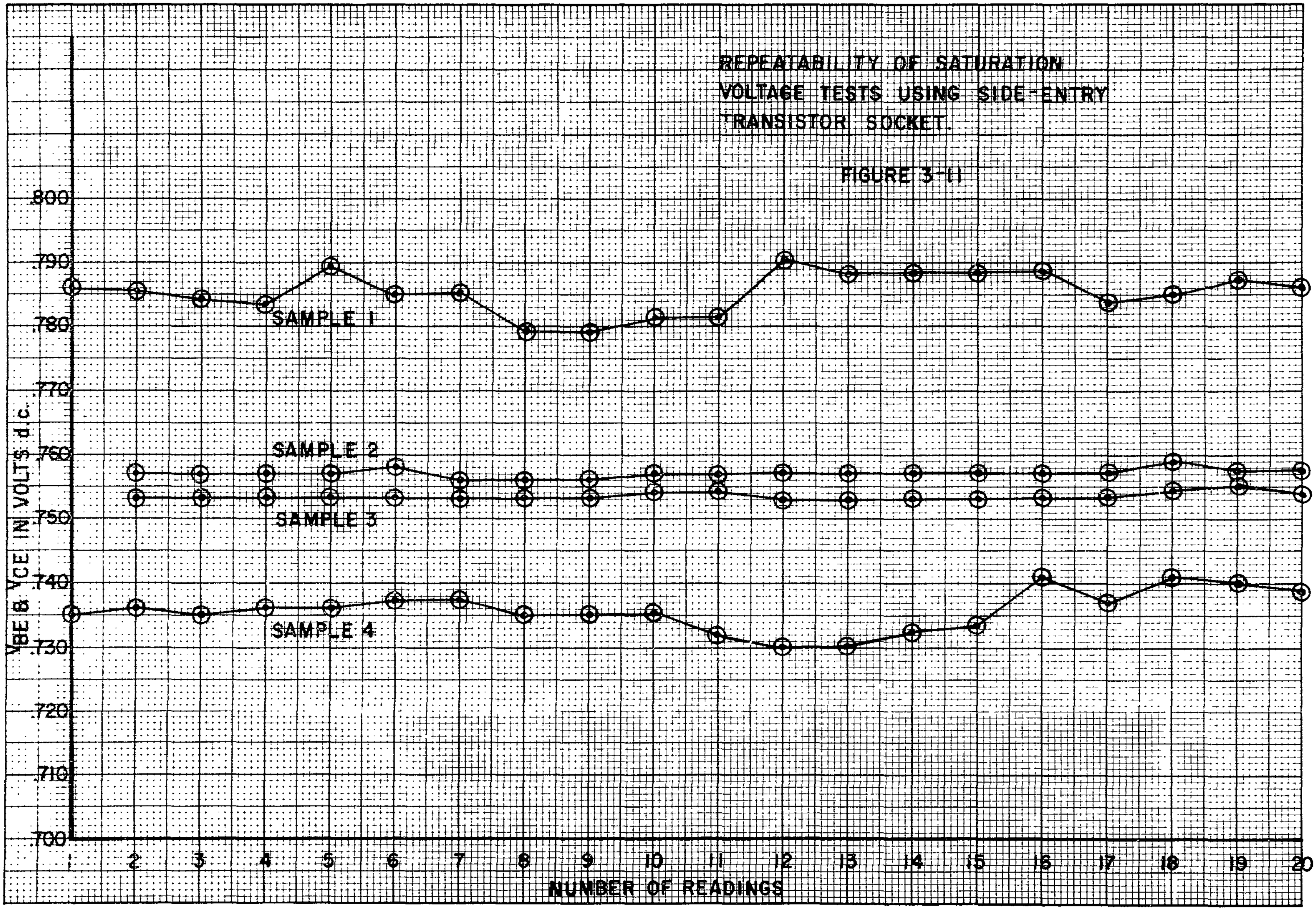
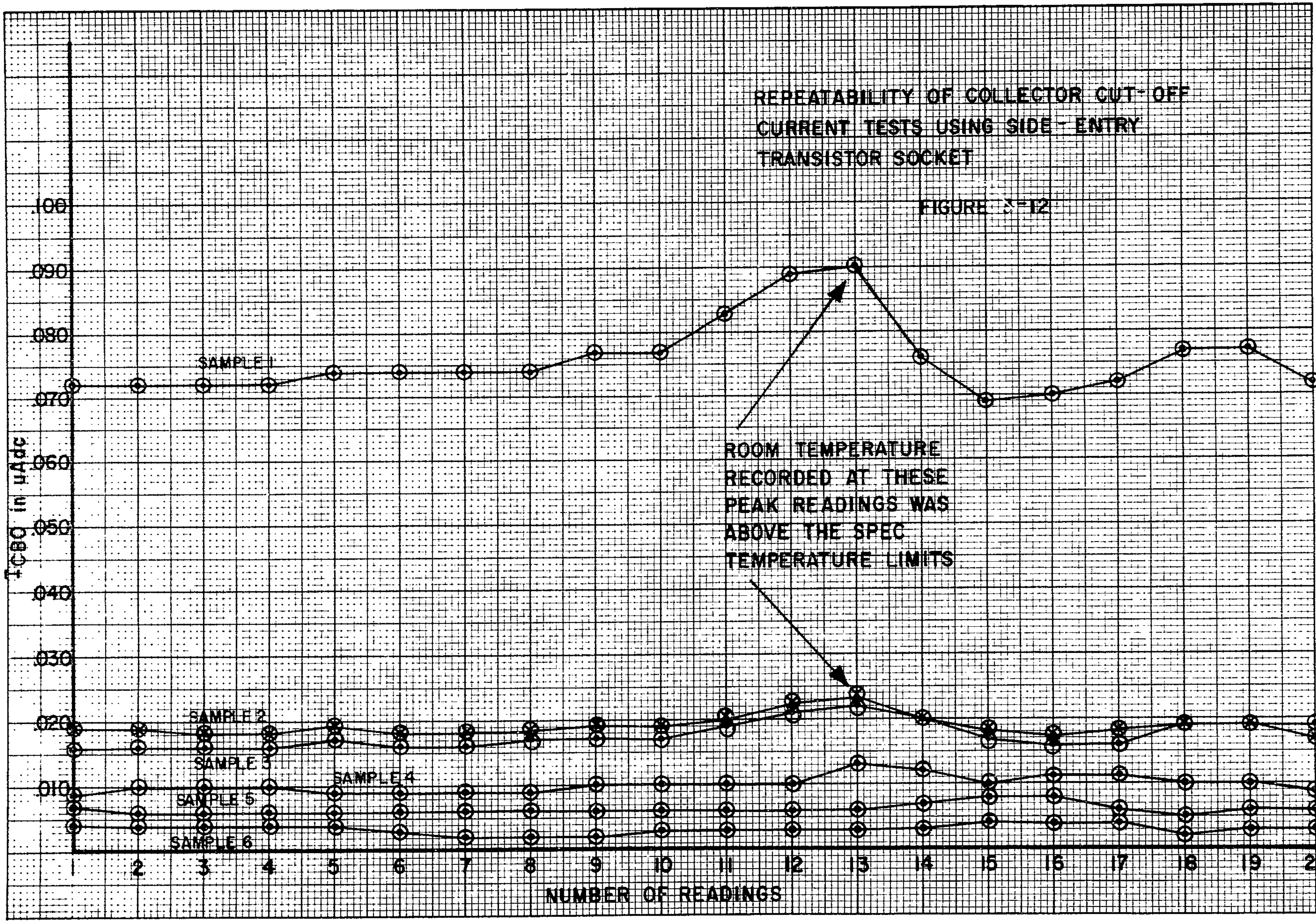
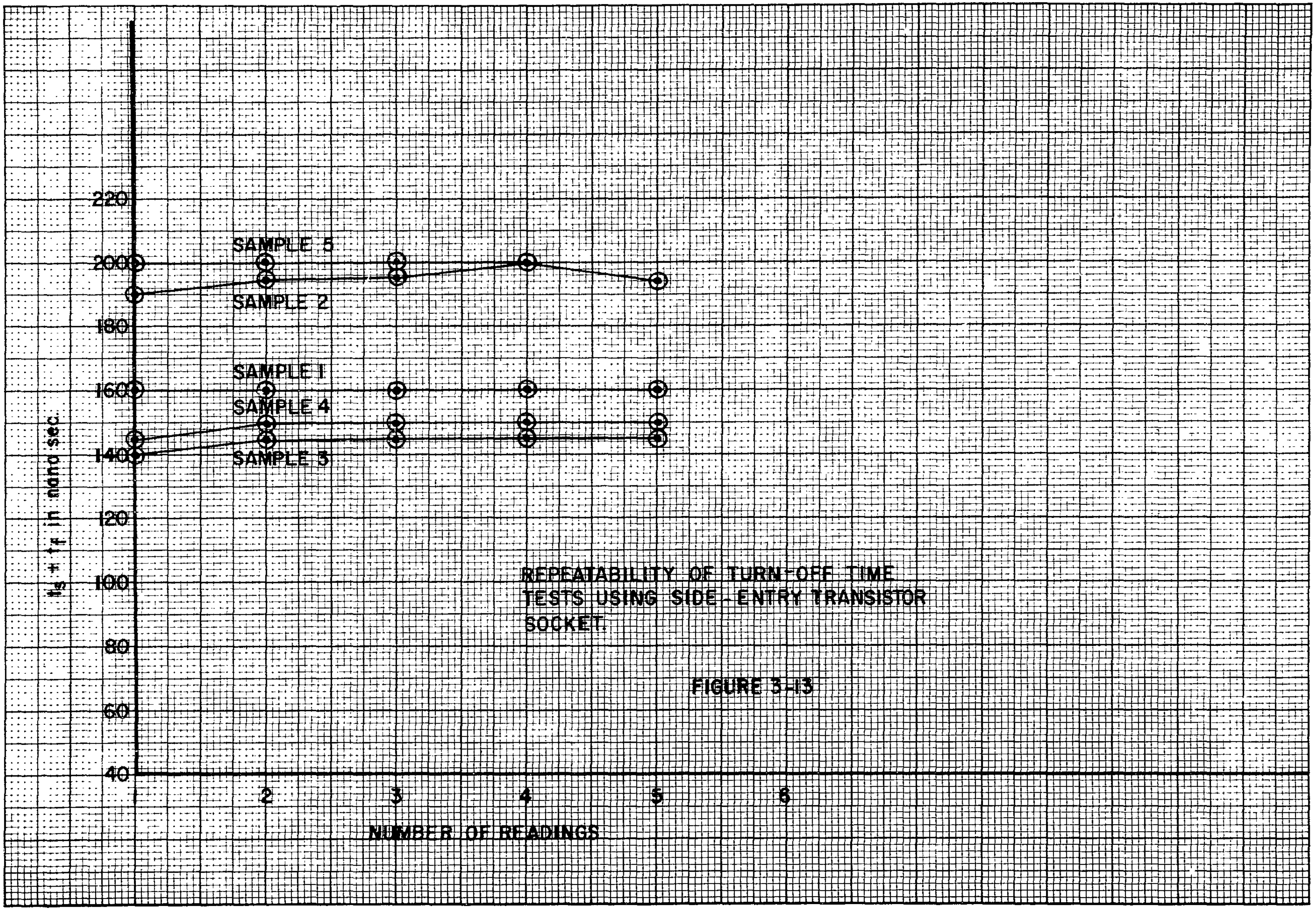


FIGURE 3-9.

REJECTING MECHANISM OF THE SAMPLE ASSEMBLY

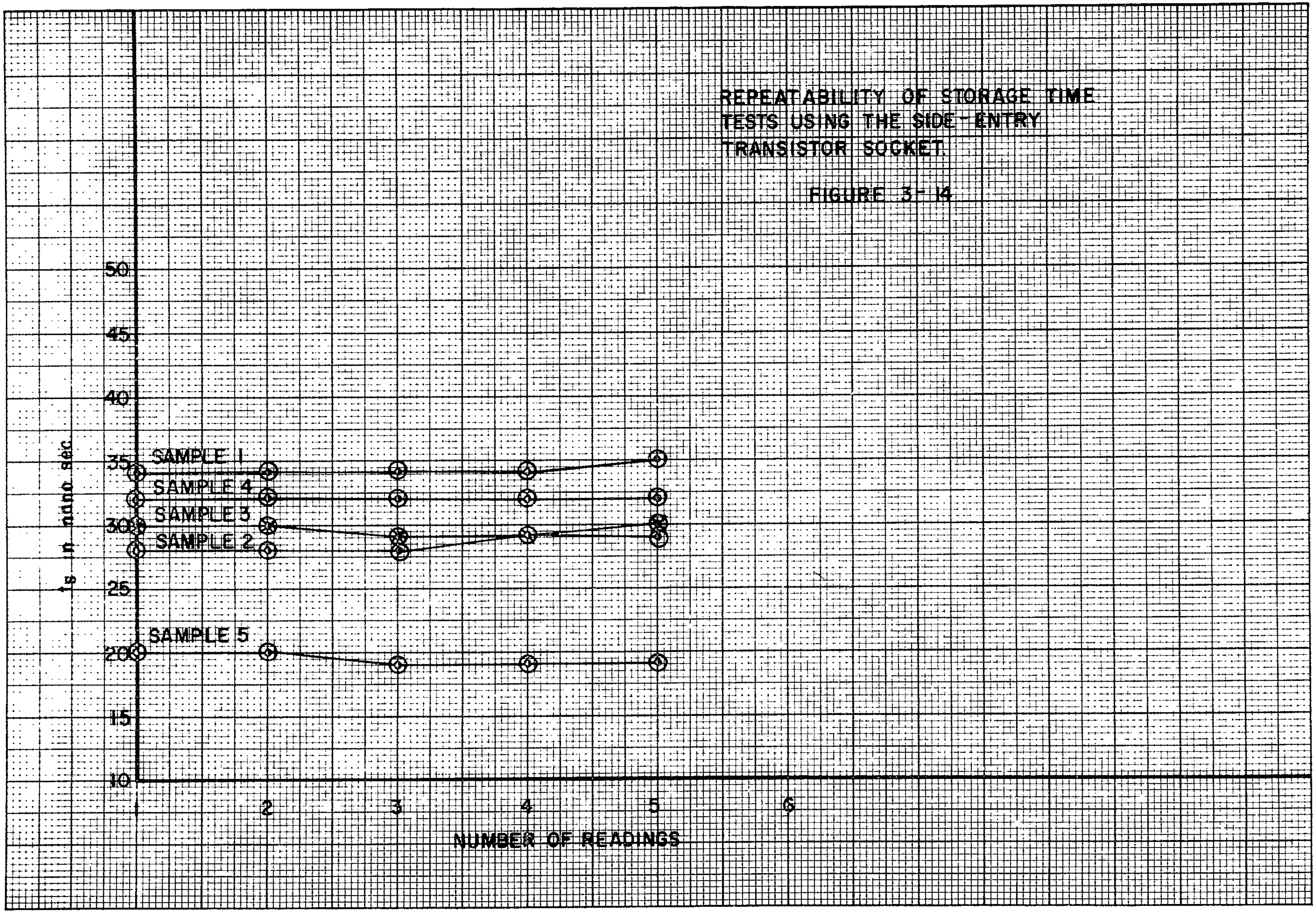

REPEATABILITY OF SATURATION
VOLTAGE TESTS USING SIDE-ENTRY
TRANSISTOR SOCKET.
FIGURE 3-11
SAMPLE 1
SAMPLE 2
SAMPLE 3
SAMPLE 4
VBE & VCE IN VOLTS d.c.
.800
.790
.780
.770
.760
.750
.740
.730
.720
.710
.700
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
NUMBER OF READINGS


REPEATABILITY OF COLLECTOR CUT-OFF
CURRENT TESTS USING SIDE-ENTRY
TRANSISTOR SOCKET
FIGURE 3-12
ROOM TEMPERATURE
RECORDED AT THESE
PEAK READINGS WAS
ABOVE THE SPEC
TEMPERATURE LIMITS
SAMPLE 1
SAMPLE 2
SAMPLE 3
SAMPLE 4
SAMPLE 5
SAMPLE 6
ICBO in µAdc
.100
.090
.080
.070
.060
.050
.040
.030
.020
.010
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
NUMBER OF READINGS



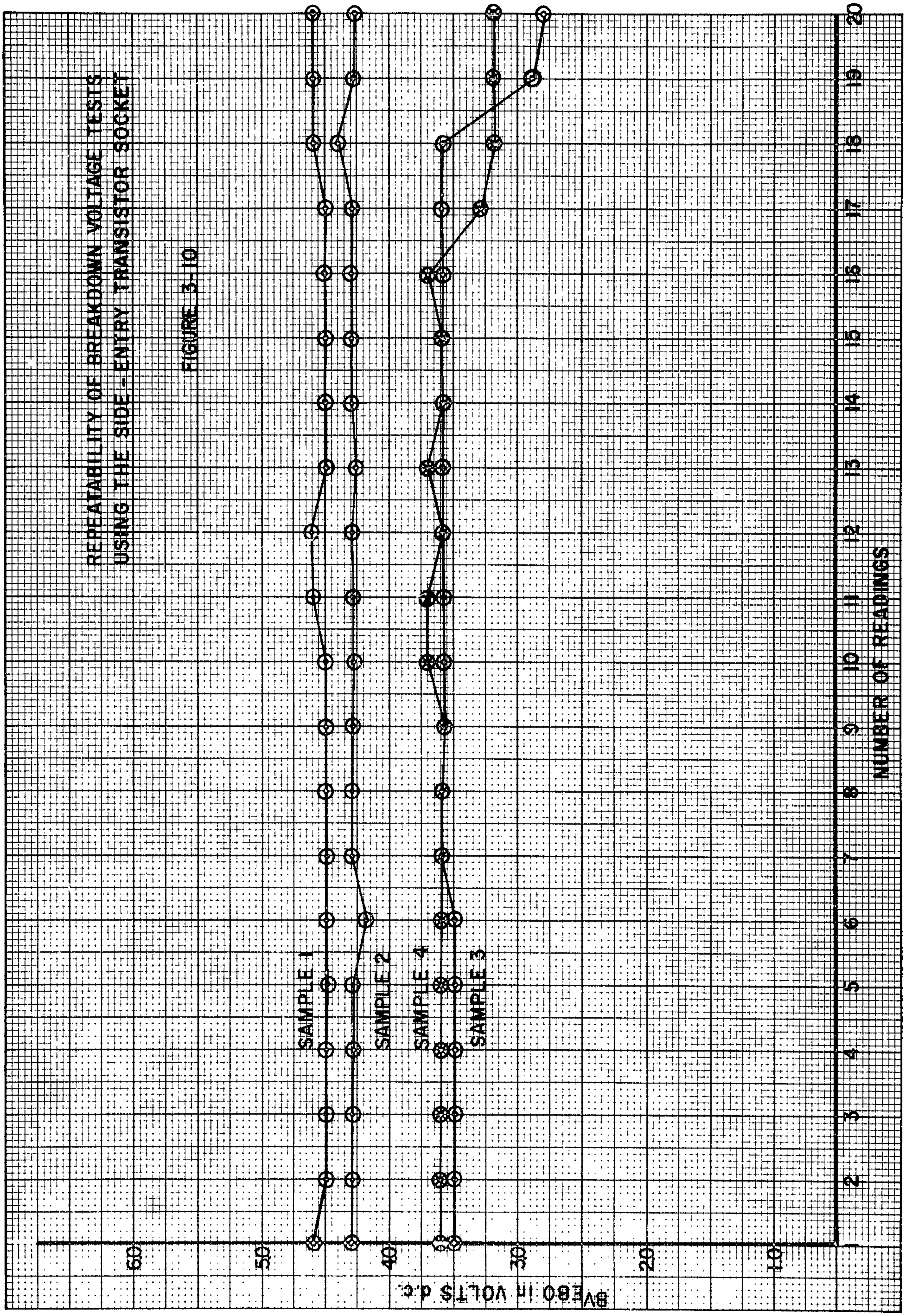
REPEATABILITY OF TURN-OFF TIME TESTS USING SIDE-ENTRY TRANSISTOR SOCKET.

FIGURE 3-13



REPEATABILITY OF STORAGE TIME TESTS USING THE SIDE-ENTRY TRANSISTOR SOCKET

FIGURE 3-14



REPEATABILITY OF BREAKDOWN VOLTAGE TESTS
USING THE SIDE - ENTRY TRANSISTOR SOCKET

FIGURE 3-10

SECTION IV

IDENTIFICATION OF PERSONNEL

1. PERSONNEL CHANGES

   None

2. ENGINEERING TIME

   Approximately 10,400 hours were spent on contracted work by Western Electric engineering personnel between June 26, 1962, and September 26, 1962.